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Soil Cap Design Criteria Report
McCormick & Baxter
Creosoting Company
Portland, Oregon

Task Order No. 71-03-12

February 13, 2004

Prepared for:
OREGON DEPARTMENT OF ENVIRONMENTAL QUALITY
811 Southwest Sixth Avenue
Portland, Oregon 97204

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List of Abbreviations and Acronyms

ACHP	Advisory Council on Historic Preservation
AOCs	areas of contamination
ARARs	applicable or relevant and appropriate requirements
BA	biological assessment
BAA	biological assessment addendum
BES	Bureau of Environmental Services
BGS	below ground surface
BIOP	Biological Opinion
BNRR	Burlington Northern Railroad
BMRP	Biological Monitoring and Reporting Plan
CAMU	Corrective Action Management Unit
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CPA	central process area
DC	Design Criteria
DEQ	Oregon Department of Environmental Quality
E & E	Ecology and Environment, Inc.
EPA	United States Environmental Protection Agency
ESA	Endangered Species Act
ESD	Explanation of Significant Difference
FEMA	Federal Emergency Management Agency
FWDA	former waste disposal area
H	horizontal
HELP	Hydrologic Evaluation of Landfill Performance
LNAPL	lighter-than-water nonaqueous phase liquid
McCormick & Baxter	McCormick & Baxter Creosoting Company, Portland Plant

List of Abbreviations and Acronyms (cont.)

NAPL	nonaqueous phase liquid
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NOAA	National Oceanic and Atmospheric Administration
NOAA Fisheries	NOAA National Marine Fisheries
NPDES	National Pollution Discharge Elimination System
NPL	National Priorities List
O&M	Operation and Maintenance
OAR	Oregon Administrative Rules
OHW	Ordinary High Water
OPDR	Office of Planning and Development Review
ORS	Oregon Revised Statutes
PAHs	polynuclear aromatic hydrocarbons
PCP	pentachlorophenol
RA	remedial action
RCRA	Resource Conservation and Recovery Act
RD	remedial design
ROD	Record of Decision
S-B	soil-bentonite
SHPO	State Historic Preservation Office
TFA	tank farm area
TPH	Total Petroleum Hydrocarbon
TRM	turf reinforcement mat
UIC	Underground Injection Control
UPRR	Union Pacific Railroad Company
USACE	United States Army Corps of Engineers
USC	United States Code
USFWS	United States Fish and Wildlife Service
V	vertical

1 Introduction and Purpose

Ecology & Environment, Inc. (E & E), under contract to the Oregon Department of Environmental Quality (DEQ; Task Order No. 71-03-12), has prepared this Design Criteria (DC) Report in support of the remedial design (RD) for contaminated soils at the McCormick & Baxter Creosoting Company, Portland Plant (McCormick & Baxter), in Portland, Oregon. The site, a former wood treating facility, is located along the Willamette River at 6900 North Edgewater Street (Figure 1). The RD and Remedial Action (RA) activities discussed in this document are in accordance with the remedy described in the Record of Decision (ROD), which was jointly issued by the United States Environmental Protection Agency (EPA) and DEQ (DEQ and EPA 1996), and in the amendment to the ROD (DEQ and EPA 1998). The ROD and select site documents can be accessed on DEQ's website (www.deq.state.or.us/nwr/mccormick.htm). The ROD identifies remedies for soil, sediment, and groundwater contaminated mainly by polynuclear aromatic hydrocarbons (PAHs), pentachlorophenol (PCP), arsenic, and dioxin/furans. The contamination resulted from wood treating operations conducted on the McCormick & Baxter site from 1944 to 1991.

DEQ is the lead agency for this site and is responsible for developing and implementing RD and RA activities. EPA is responsible for providing federal funding for these activities. DEQ also is responsible for conducting and funding long-term Operation and Maintenance (O&M), although EPA is responsible for funding O&M of groundwater cleanup activities for a period of 10 years.

The selected soil remedy for the site involves demolition and off-site disposal of structures and debris; excavation and off-site treatment and disposal of contaminated soil exceeding action levels for arsenic, PAHs, and PCP; placement of a 2-foot thick cap over soils with contamination above established protective levels but below the specified action levels for soil excavation and off-site treatment; and establishment of institutional controls for the site. As described in section 3.1, many components of the soil remedy were completed in 1999 as part of Phase I. The components of the selected soil remedy that remain are the installation of a soil cap and the establishment of institutional controls for the site.

The purpose of this document is to present the technical parameters and basis upon which the soil cap will be designed. Furthermore, this document will be used by DEQ to solicit input from DEQ and EPA staff, Trustees, Tribes, City of Portland, Metro and other interested parties. Comments and questions regarding this document should be forwarded to Mr. Kevin Parrett, the DEQ project manager, by telephone at 503-229-6748 or by email at parrett.kevin@deq.state.or.us. A response to comments on this report will be provided in the form of an addendum.

This document fulfills part of the RD process and is based on EPA (1995) guidance, the results of data analyses, and preliminary input from DEQ, EPA, the United States Army Corps of Engineers (USACE) under contract to the DEQ, E & E, the National Oceanic and Atmospheric Administration (NOAA), several Native American Tribes and the City of Portland.

2 Background Information

2.1 Site Description

The McCormick & Baxter site (see Figure 1) is located on the Willamette River in Portland, Oregon, near River Mile 7, downstream of Swan Island and upstream of the St. Johns Bridge. The Willamette River flows to the northwest in the vicinity of the site. The site, which encompasses approximately 43 acres on land, is generally flat and lies between a 120-foot-high bluff near the northeastern border and a 20-foot-high bank along the Willamette River to the southwest. Approximately 23 acres of contaminated sediments, to be capped as part of the sediment remedy, also are considered part of the "site" although the responsible party does not legally own them. The upland portion of the site is located within the floodplain of the Willamette River in an area that was constructed by placement of dredged material sometime in the early 1900s. A sandy beach is exposed at the base of the bank except during brief periods of high river stage, which generally occurs during late winter or early spring.

The site is bordered by inactive industrial properties along the river and by a residential area on the bluff. A Burlington Northern Railroad (BNRR) spur crosses the western portion of the property and the Union Pacific Railroad borders the site to the east below the bluff. The entire property is fenced, and warning signs are posted on the fence.

In the early 1900s the first industrial structure, a sawmill, was built on the site. In 1944, the McCormick & Baxter Creosoting Company began wood-treating operations that continued until October 10, 1991. Figure 2 is a circa 1973 aerial photo of the site. Four retorts at the site were used for various wood-treatment processes:

- Retort 1: Creosote in aromatic oils (1945 to 1991);
- Retorts 2 and 4: PCP in aromatic oils (1953 to 1991);
- Retort 3: Water-based treatment (chromium from 1954 to 1970, ammoniacal copper arsenate from 1970 to 1986, and ammoniacal copper zinc arsenate from 1986 to 1991); and
- Retort 4: Cellon (PCP in liquid butane and isopropyl ether from 1968 to 1988).

Also present at the site were 750,000-gallon creosote tanks within a dike and a diked tank farm with several additional tanks for storing wood-treatment chemicals. Chemicals for water-based treatments were stored in tanks near Retort 3. Chemicals that remained following shutdown of the site were inventoried and removed by DEQ in 1992 during an interim site stabilization action. All chemical storage tanks and retorts were cleaned, dismantled, and removed by DEQ in 1994.

From 1950 to 1965, waste oil containing creosote and/or PCP was applied to site soil for dust suppression in the central process area (CPA). Liquid process wastes reportedly were discharged to a low area near the tank farm before 1971 (E & E 1983). Contaminated soil was removed from this area in the mid-1980s. From 1968 to 1971, process wastes were disposed of in the former waste disposal area (FWDA) in the southwest portion of the site.

The site included a wastewater discharge outfall that was used to discharge cooling water when the plant was operating. Contact wastewater also was discharged from this outfall in the early years of operation. Three stormwater outfalls also were present along the river. Two of the outfalls were permitted under the National Pollutant Discharge Elimination System (NPDES). Following plant shutdown, DEQ placed earthen berms around stormwater collection sumps at the site as an early response action to minimize off-site discharge. The stormwater outfalls were removed as part of the Phase I soil RA in early 1999. Currently, stormwater at the site infiltrates the subsurface.

2.2 Site Regulatory History

McCormick & Baxter identified environmental problems at the site during a preliminary site investigation and reported these findings to DEQ in August 1983. Subsequently, McCormick & Baxter retained a contractor to conduct environmental investigations on the property. McCormick & Baxter submitted investigation reports to DEQ in January 1985 and February 1987. Primary sources of contamination were identified as the tank farm area (TFA), the FWDA, the Cellon (PCP in butane and ether) wash area, and areas where treated wood was stored.

DEQ entered into a Stipulated Order with McCormick & Baxter in November 1987, requiring the following corrective actions:

- Installation of extraction wells in the TFA and FWDA;
- Design and installation of a groundwater pump-and-treat system, and groundwater monitoring program;
- Construction of covered storage areas for treated wood;
- Construction of drip pads in front of the retorts;
- Collection and treatment of stormwater; and
- Performance of surface soil bioremediation treatment studies.

In December 1988, McCormick & Baxter filed for Chapter 11 bankruptcy, and in 1990, DEQ assumed responsibility for completing investigation and cleanup activities at the site.

The McCormick & Baxter site was proposed for addition to the National Priorities List (NPL) on June 18, 1993. The site was added to the NPL on June 1, 1994. In March 1996, after a detailed study of the nature and extent of contamination at the site and a detailed analysis of cleanup alternatives, a remedy for the site was selected and described in the ROD. Changes to the ROD have been documented in the 1998 ROD Amendment and the 2002 Explanation of Significant Difference (ESD).

2.3 Current Site Configuration

The McCormick & Baxter site is accessed via the partially paved North Edgewater Street, which leads from Willamette Boulevard to the main gate near the northwest corner of the site. The driveway leading into the property and the parking lot are paved; the remainder of the property is unpaved, covered with gravel, or vegetated. Figure 3 is an aerial photo showing the current site configuration. Two construction trailers are maintained in the parking lot area to provide office space, storage, and personnel decontamination facilities for ongoing site activities. The remaining aboveground structures on site include: a former shop building that once housed a water treatment system (no longer in operation) and other equipment/supplies; a freight container located near the western property corner, which also formerly housed a water treatment system (no longer in operation); four aboveground tanks used for water treatment operations (no longer in operation); a small metal shed containing a water service backflow prevention device; several utility poles; and a wood retaining wall and pilings along the river bank. All other aboveground structures and buildings were removed during previous RA activities. The entire site is fenced, and warning signs are posted on the fence around the perimeter of the site.

Utility service at the site includes water provided by the City of Portland to the office trailers, the former shop building, and several fire hydrants. Electrical service is provided by Portland General Electric Company to the office trailers, the former shop building, the FWDA groundwater treatment system, and lights mounted on several overhead poles. Two pressurized sewer lines, owned by the City of Portland, are located adjacent to the BNRR tracks. A natural gas line on the property has been capped and abandoned. One combined sewer line is located adjacent to the former Riedel International property on the east side of the site.

The (upland) site is bordered by the following neighboring properties:

- BNRR Company located to the north;
- Union Pacific Railroad Company (UPRR) located to the east;
- Triangle Park LLC located to the southeast; and
- Division of State Lands, owner of submerged and submersible lands within the Willamette River, located to the south.

2.4 Nature and Extent of Contamination

Three main contaminant source areas exist at the site: the FWDA, the CPA, and the TFA. The main site related groundwater contaminants from these areas are PAHs, PCP, and metals associated with wood-treating solutions. Releases of nonaqueous phase liquid (NAPL) contaminants from the main source areas at the site, particularly from the TFA and FWDA, mainly have affected the shallow aquifer. Site contaminant plumes contain either lighter-than-water nonaqueous phase liquid (LNAPL), denser-than-water nonaqueous phase liquid, or both, consisting of creosote compounds; the plumes also contain dissolved-phase contaminants. Contaminant flux occurs from groundwater in the shallow aquifer to the Willamette River, as evidenced by river seeps at low tides and low river stage.

Results of sediment sampling indicate that high concentrations of PAHs were detected where LNAPL releases near the creosote dock, downstream in Willamette Cove, and along the sediment drop-off along the harbor line are known or suspected to have occurred. Concentrations of other contaminants of concern generally did not exceed ROD cleanup levels.

In 1996 and 1997, extensive surface (0 to 6 inches below ground surface [BGS]) and subsurface (4 to 10 feet BGS) soil samples were collected and analyzed (E & E 1998) in an effort to delineate the most heavily contaminated soils for excavation and treatment in Phase I of the soil RA. In 1999, areas where contaminant concentrations in soil samples exceeded "action levels" as defined in the ROD, were excavated and soil was removed from the site. The *Revised Final Remedial Design Data Summary Report* (E & E 1998) depicts the locations of residually contaminated surface soil and concludes that the entire upland area of the site should be capped.

2.5 Record of Decision and Remedial Actions Performed

The 1996 ROD, 1998 Amended ROD and 2002 ESD identify a series of RAs that address the principal threats at the McCormick & Baxter site by removing the most highly contaminated soil, extracting NAPL from and treating the contaminated groundwater, installing a subsurface barrier wall, and capping contaminated sediment.

Over the past several years, several inspections, investigations, and RAs have been performed at the site. Most recently (Spring/Summer 2003), a vertical barrier wall was installed as a contingency to the selected groundwater remedy. The groundwater remedy at the site was designed to separate NAPL from the groundwater and to treat groundwater removed from the TFA through total fluid extraction. In addition, pure-phase NAPL extraction is performed in the TFA and the FWDA. NAPL extraction was implemented to reduce NAPL pools to residual levels and to minimize or prevent NAPL migration into the Willamette River and its sediment. Ongoing monitoring indicated that the groundwater remedy was not preventing the discharge of NAPL from the site to the Willamette River and its sediment. Because of continued NAPL migration, DEQ and EPA elected to implement construction of a combined sheet pile and soil-bentonite (S-B) barrier wall. This decision was documented in the 2002 ESD. The barrier wall, which fully encompasses the main area of contamination, was installed to attain hydraulic control of NAPL and groundwater to reduce off-site NAPL migration. The selected alignment consists of a fully encompassing wall, the downgradient portion constructed of sheet pile, and the upgradient portion constructed of S-B backfill using a slurry trench method.

For sediment, the ROD specifies installation of a cap over areas that contain site contaminants in the near surface above human health and ecological risk-based protective levels or that exhibit significant biological toxicity. The RD for sediment is complete and site preparation and construction activities for RA are scheduled to begin in spring 2004. The sediment cap will cover approximately 23 acres of sediments located below Ordinary High Water (OHW) of the Willamette River (elevation of 16.6 feet NGVD). Landward of the OHW mark the cap will extend an average of 130 feet and cover 5.5 acres.

The major components and the status of the selected soil remedy, the subject of this report, are described in Section 3.1.

3 Design Constraints

Sections 3.1 (Selected Soil Remedy) and 3.2 (Regulatory Considerations) address required elements of the soil cap design as directed in the ROD and ROD amendment. Section 3.3 (Future Land Use) addresses land use considerations as practical constraints of the cap design.

3.1 Selected Soil Remedy

The original soil remedy in the 1996 ROD called for excavation and on-site biological treatment of contaminated soils, with an estimated 1,000 cubic yards of highly contaminated soil and other wastes requiring off-site treatment and disposal. The 1,000 cubic yards was to include soil with significant dioxin concentrations (i.e. several orders of magnitude above protective levels). This was to be placed in a land treatment cell, designated as a Resource Conservation and Recovery Act (RCRA) Corrective Action Management Unit (CAMU). After the ROD was signed, DEQ initiated the detailed design of the selected soil remedy, including additional soil sampling. Based on the data gathered during the sampling, DEQ determined that dioxin contamination of soils was more widespread than previously reported. The volume of soil with significant levels of dioxin was estimated to be approximately 20,000 cubic yards, versus the 1,000 cubic yards estimated in the 1996 ROD. In addition, dioxin contamination was predominately located in the same areas where elevated concentrations of PCP and PAHs were found in soils. In 1998 the ROD was amended to change the component of the selected soil remedy that called for on-site biological treatment of contaminated soil. The amendment was made mainly because biological treatment had not been demonstrated to be effective at significantly reducing dioxin concentrations in soil. Because significant levels of dioxin were present in soil areas originally identified for excavation and on-site biological treatment, the intended treatment apparently was not likely to achieve the level of risk reduction contemplated in the 1996 ROD. Accordingly, DEQ and EPA selected an alternative remedy for contaminated soil at the McCormick & Baxter site.

The major components of the selected remedy and their status are described in the following subsections.

3.1.1 Demolition and Removal of Aboveground Structures and Debris

Demolition and off-site disposal or recycling (except for concrete rubble) of aboveground structures and debris, and underground structures, that interfered with soil excavation were completed as part of the Phase I soil RA in 1999. The only remaining aboveground structures on site, as described in the Section 2.3, are a former shop building, a freight container located near the western property corner, four aboveground tanks used for water treatment operations (no longer in operation), a small metal shed containing a water service backflow prevention device, several utility poles, and a wood retaining wall and pilings along the river bank. The wood-retaining wall and pilings along the riverbank will be removed as part of the preparation for construction of the sediment cap.

3.1.2 Excavation of Contaminated Soil

In 1999, areas where soil samples exceeded "action levels" as defined in the ROD, were excavated and soil was removed from the site. Excavation was completed to a depth of approximately 4 feet, and in some areas up to 10 feet. Soils were removed from the site for proper treatment and disposal at a RCRA permitted hazardous waste disposal facility.

3.1.3 Backfilling of In-Ground Sumps, and Vaults

In-ground concrete sumps, vaults, etc. were backfilled with concrete rubble from aboveground demolition activities at the time of demolition. In addition, soil excavations were backfilled with clean fill imported by barge to the site from a quarry located on the Columbia River in Avery, Washington.

3.1.4 Placement of 2-Foot Thick, Clean Soil Cap

The ROD and ROD Amendment call for the placement of a 2-foot thick, clean soil cap over the entire site. Following is an excerpt from the ROD describing the site cap:

> *The cap will consist of layers of soil covered with a layer of topsoil to promote revegetation. Special provisions may be necessary for placement of the cap around monitoring or extraction wells. A geotextile liner will be placed between the cap and the treatment and consolidation cells [this provision was eliminated in the ROD Amendment]. A 3-inch gravel demarcation layer will be placed under the cap on the remainder of the site to provide a visible separation between the cap and underlying soil containing residual contamination. A nominal cap thickness of 2 feet will be used to provide isolation of contaminants. The cap will also be vegetated and will include a storm water collection system to reduce the potential for erosion from or pooling of surface water. Actual cap design and extent will be determined during remedial design activities. DEQ and EPA will consider alternatives for transport of soil for the cap (including the sediment cap) that do not involve hauling materials through the St. John's neighborhood.*

> *Additional soil to increase the thickness of the cap may be added or required of future landowners when zoning and future property use become more firmly established. The appropriate cap thickness would take into consideration building foundations; root depth for grasses, bushes, and trees; and surface contours. The actual thickness of the cap and the soil/material type used may vary depending on developments in land ownership, land use zoning and use designation, and engineering specifications. Development on the site will only be allowed when land users can demonstrate to DEQ and EPA that protectiveness can be maintained and that the contemplated use is consistent with the level of protection achieved by the cleanup. DEQ and EPA will resample the unpaved portions of North Edgewater Street to determine if contaminant concentrations exceed action levels. The unpaved areas that exceed action levels will be covered with a 3-inch layer of asphalt.*

The 2002 ESD further considered the permeability of the soil cap by stating:

> *DEQ and EPA will consider the use of impermeable or semi-permeable features in the soil cap during its design. NOAA and NMFS* [NOAA Fisheries] *have recommended the site cap be impermeable to minimize infiltration and the quantity of groundwater potentially flowing through the primary source areas [i.e., within the barrier wall]. The ROD provided for construction of a soil cap on the site; however, an impermeable soil cap was not considered necessary to be protective of groundwater. Groundwater data obtained following construction of the barrier wall will be assessed to determine whether additional measures would be appropriate to minimize surface water infiltration into the NAPL source areas contained within the fully encompassing barrier wall.*

A more detailed discussion of the soil cap elements is provided in Section 4

3.1.5 Long-Term Maintenance of the Cap

As specified in the ROD, regular, visual inspections of the cap, especially along the perimeter where erosional forces may be highest, will ensure the cap remains intact and effective. Other visual indicators such as stressed vegetation, or pooling of surface water indicating subsidence, also will be used to monitor the effectiveness of the cap. The cap will be inspected regularly. Repairs will be conducted as necessary to ensure the integrity of the cap. Other measures to protect the cap (e.g., fencing, access restrictions) are discussed below as part of Institutional Controls.

3.1.6 Establishment of Institutional Controls

The establishment of institutional controls, as described in the 1996 ROD, includes, but is not limited to, deed notices containing information regarding the levels and locations of contamination on the property, and deed restrictions, such as environmental easements or restrictive covenants limiting future uses of the site to industrial/commercial or open-space recreational activities. The deed restrictions will prohibit future land uses not consistent with the level of protectiveness achieved by the cleanup. Deed restrictions may also include requirements for routine maintenance and repair of the cap, and restrictions on soil excavation activities without necessary health and safety measures, during installation or maintenance of underground utilities by future owners or lessees, as applicable. The deed restrictions will be set forth in a DEQ-approved form, running with the land and enforceable by DEQ against present and future owners of the property.

3.2 Regulatory Considerations

Cleanup or remedial actions must comply with applicable or relevant and appropriate requirements (ARARs) under federal environmental laws and State environmental or facility siting laws. Identification of ARARs must be done on a site-specific and action-specific basis. Although the on-site portions of cleanup activities at Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites are exempt from permitting requirements, they must meet the substantive requirements of the ARARs. The ROD provides a detailed discussion of potential ARARs for a wide range of activities at the site. Following is a preliminary identification of the significant ARARs for the soil cap.

CERCLA also exempts local permits and procedural requirements and excludes local laws from substantive ARARs. While there is no EPA duty under CERCLA to satisfy local substantive requirements, DEQ nonetheless intends to coordinate with the City of Portland in order to address city requirements in project design to the extent practicable.

3.2.1 Federal Requirements

The federal regulations applicable to the soil cap are discussed below.

3.2.1.1 Executive Order 11988: Flood Plain Management

Executive Order 11988, codified in 40 CFR 6.302 and 40 CFR 6 Appendix A, requires federal agencies carrying out their responsibilities to take action to reduce the risk of flood loss; to minimize the impact of floods on human safety, health, and welfare; and to restore and preserve the natural and beneficial values served by floodplains. To do this, federal agencies must evaluate the potential effects of any actions they may take in a floodplain to ensure that their planning programs and budget requests reflect consideration of flood hazards and floodplain management, including the restoration and preservation of such land areas as natural, undeveloped floodplains. This order emphasizes the importance of evaluating alternatives to avoid impacts and incompatible development in floodplains; minimizing the potential harm to floodplains if the only practicable alternative requires siting an action in a floodplain; and providing early and adequate opportunities for public review of plans and proposals involving actions in floodplains. Within the Lower Willamette River, floodplain management is administered jointly by Federal Emergency Management Agency (FEMA) and the City of Portland Office of Planning and Development Review (OPDR).

This regulation is applicable or relevant and appropriate to the soil cap because portions of the (upland) site are believed to be located below the City of Portland's 100-year floodplain. Placement of capping material (i.e., fill) below this elevation will be subject to the substantive requirements of Executive Order 11988 and subsequent Federal Regulations.

3.2.1.2 Solid Waste Disposal Act (Resource Conservation and Recovery Act, Subchapter III)

State management of hazardous substances is authorized in the Oregon Hazardous Waste Management Act (Oregon Revised Statute 466.005 et seq.). The law is implemented by regulations that are codified at Oregon Administrative Rule 340-100-001 et seq. Oregon hazardous waste management regulations adopt by reference most of the substantive provisions of Subtitle C of RCRA. Subtitle C is the main federal law for the management of hazardous waste. The principal federal regulations that implement Subtitle C are codified in 40 Code of Federal Regulations (CFR) 260 to 271. If federal and Oregon hazardous waste laws conflict, the more stringent law will be followed. These regulations address requirements for defining, characterizing, and listing hazardous wastes; for generators, pertaining to manifesting, transporting, and record keeping; for transporters, pertaining to shipment of hazardous waste off site; and for land disposal restrictions. These regulations are applicable to the excavation, characterization, transportation, treatment, and disposal of contaminated soil from the site. This regulation is applicable or relevant and appropriate to the off-site transport and disposal of any solid waste that may be specified in the soil cap design.

3.2.1.3 Endangered Species Act, Section 7

The Endangered Species Act (ESA) requires federal agencies to consult or confer with the United States Fish and Wildlife Service (USFWS) and the NOAA National Marine Fisheries (NOAA Fisheries) before taking federal action. Consultation may occur when there is discretionary federal involvement or control over the action, whether apparent, such as the issuance of a new federal permit, or less direct, such as state operation of a program with federal oversight (50 CFR 402.02 and 402.10). EPA, as the federal action agency for the McCormick & Baxter site, must determine whether a threatened or endangered species, or its critical habitat, will be affected by a proposed action. If EPA concludes that threatened or endangered species are not present or will not be affected, then no further analysis or action is required for compliance. If EPA concludes that threatened or endangered species or their habitat may be affected, a biological assessment (BA) is prepared and EPA must consult with the USFWS and the NOAA Fisheries. The purposes of the consultation include the identification of potential effects of the action (direct, indirect, and cumulative) and the development of reasonable and prudent measures to avoid or minimize any adverse effects. USFWS and NOAA Fisheries will provide either formal or informal feedback to EPA during this time.

The Federal listed species that fall within the action area of the McCormick & Baxter Site are:

- Lower Columbia River Chinook Salmon (Oncorhynchus tshawytscha)
- Upper Willamette River Chinook Salmon (Oncorhynchus tshawytscha)
- Lower Columbia River Steelhead (Oncorhynchus mykiss)
- Upper Willamette River Steelhead (Oncorhynchus mykiss)
- Columbia River Chum Salmon (Oncorhynchus keta)
- Bald Eagle (Haliaeetus leucocephalus)
- Golden Paintbrush (Castilleja levisecta)
- Water Howellia (Howellia aquatilis)
- Bradshaw's lomatium (Lomatium bradshawii)
- Nelson's checker-mallow (Sidalcea nelsoniana)
- Willamette daisy (Erigeron decumbens var. decumbens)
- Kincaid's lupine (Lupinus sulphureus var. kincaidii)

A BA was prepared for the overall project that was also specific to the construction of the barrier wall (*Biological Assessment, McCormick and Baxter Creosoting Company, Portland, Oregon – June 2002*) and a biological opinion (BIOP) was issued by NOAA Fisheries (NOAA 2002). Substantive compliance with regulations prescribed under the ESA was required for barrier wall construction since activities had the potential for impact to listed salmonid species (e.g., chinook salmon) in the Willamette River. E & E developed a *Biological Monitoring and Reporting Plan* (BMRP) and a *Pollution Control Plan* that were used by field barrier wall construction oversight personnel to implement conservation measures prescribed in the NOAA Fisheries BIOP (NOAA 2002). A biological assessment addendum (BAA) has been developed by EPA for the sediment cap construction (*Biological Assessment Addendum, McCormick and Baxter Creosoting Company, Portland, Oregon, Sediment Cap, October 2003*). A BIOP for the sediment cap is pending.

This regulation is applicable or relevant and appropriate because EPA will need to submit a BAA to the USFWS and NOAA Fisheries requesting further consultation on the soil cap. It is anticipated that a BAA for the soil cap will be completed concurrent with the Prefinal Design.

3.2.1.4 United States Environmental Protection Agency Area of Contamination Policy

The EPA Area of Contamination Policy, discussed in the preamble to the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (Federal Register Vol. 55, No. 46, March 8, 1990, pp. 8758-8760), clarifies that certain discrete areas of generally dispersed contamination (called areas of contamination or AOCs) could be equated to a RCRA landfill and that movement of hazardous wastes within those areas would not be considered land disposal and would not trigger the RCRA land disposal restrictions. The NCP also discusses use of the concept of "placement" to determine which requirements might apply in the AOC. Placement of hazardous waste into a landfill or other land-based unit is considered land disposal, which triggers the land disposal restrictions, and may trigger other RCRA requirements including permitting (at a non-CERCLA site), closure, and post-closure. In the NCP, EPA states that, "placement does not occur when waste is consolidated within an AOC, when it is treated in-situ, or when it is left in place." Placement does occur, and additional RCRA requirements may be triggered, when wastes are moved from one AOC to another or when waste is actively managed within or outside the AOC and returned to the land.

The AOC provision is applicable or relevant and appropriate because grading and potential stockpiling of soils will be conducted in the AOC at the site. The ROD amendment removed the CAMU designation from the site since the on-site treatment of soils had been eliminated.

3.2.1.5 National Historic Preservation Act

The National Historic Preservation Act requires federal agencies to take into account the effects of federal undertakings on any historic properties listed on, or eligible for inclusion on, the National Register of Historic Places, and to avoid, minimize, or mitigate any adverse effects on such properties (16 United States Code 470). EPA, as the federal action agency for the McCormick & Baxter site, has a responsibility to determine whether CERCLA RAs could affect historic or cultural properties. EPA has identified Native American tribes that might attach religious and cultural significance to the project area and invited them to be consulting parties. EPA has used the consultation process with the appropriate tribal governments as a means to help identify and evaluate important cultural resources that may be affected by RAs at the McCormick & Baxter site. Consultation also will respect tribal sovereignty and the government-to-government relationship between the federal government and Native American tribes. EPA is required to provide a reasonable opportunity for the Advisory Council on Historic Preservation (ACHP) to comment on the proposed action. The State Historic Preservation Office typically assists ACHP with its review and comment on the proposed action.

To assure compliance with the National Historic Preservation Act (16 United States Code [USC] 470) and applicable Oregon statutes (Oregon Revised Statutes (URS) 97.740 et seq., 358.905 et seq., and 390.235 et seq.), procedures have been developed to address potential inadvertent discoveries of cultural materials and deposits (including sacred objects, funerary objects, and objects of cultural patrimony as defined in ORS 358.905) and Indian burials and human remains (as defined in ORS 358.905) during ground disturbing activities at the site.

DEQ assisted EPA in preparing a Cultural Resources Survey prior to construction of the subsurface barrier wall and prior to completing the sediment cap. Based on the findings of this assessment, DEQ developed an Archaeological Monitoring Protocol to address the potential for inadvertently uncovering Native American archaeological recourses during excavation activities. EPA has submitted these documents to the State Historic Preservation Office (SHPO) and has consulted with the Tribes in preparing these documents. This regulation is applicable for the soil cap because EPA will continue to consult with the Tribes and SHPO prior for the implementation of this federal action.

3.2.2 State Requirements

The State regulations applicable to the soil cap are discussed below.

3.2.2.1 Oregon Department of Environmental Quality - Solid Waste Rules Defining "Clean Fill"

DEQ's Solid Waste Rules define "clean fill" in Oregon Administrative Rules (OAR) 340-093-0030(13). Soil that has been evaluated and found not to contain contaminants that could adversely impact waters of the state or public health, and soil that has been generated from a site that has no history of contamination and does not otherwise have any indication of contamination, may be used and managed as "clean fill."

Soil that does not meet the criteria described above for "clean fill" may be evaluated to determine if it meets the "substantially the same as clean fill" criteria set out in OAR 340-093-0080(2). Among other requirements of OAR 340-093-0080(2), concentrations of hazardous substances in the soil must meet the EPA Region IX's residential soil preliminary remediation goals, the EPA Region IX's soil screening level migration to groundwater, or the screening level values for ecological receptors, whichever is lower. In addition, for total petroleum hydrocarbon (TPH) contamination, the Level 1 standards presented in OAR 340-122-335 must be met.

This regulation is also applicable or relevant and appropriate because soil that meets either the definition of "clean fill" under OAR 340-093-0030(13) or the standards for "substantially the same as clean fill" under OAR 340-093-0080(2) will satisfy the "clean soil" requirements for the McCormick & Baxter soil cap.

3.2.2.2 Oregon Department of Environmental Quality - Clean Water Act

Section 401 of the federal Clean Water Act requires that any applicant for a federal license or permit to conduct any activity that may result in a discharge to waters of the state must provide that licensing or permitting agency with a certification from DEQ stating that the activity complies with water quality requirements and standards. Although DEQ administers the Section 401 water quality certification process and the USACE coordinates with DEQ on water-quality-related permitting conditions, EPA assumes responsibility at CERCLA Sites for verifying that the substantive requirements of Section 401 of the Clean

Water Act are met. Section 401 of the Clean Water Act is anticipated to be applicable because the soil cap may be designed to discharge surface water runoff to the Willamette River.

DEQ administers the NPDES program for the State of Oregon. Under this program an NPDES #1200-C storm water general permit would be required for project construction activities that disturb five or more acres. Additionally, a Storm Water Pollution Control Plan and a Spill Prevention Control and Countermeasure Plan are required to be submitted with the NPDES #1200-C permit application. Regulations governing the NPDES are applicable or relevant and appropriate because the soil cap will disturb approximately 43 acres.

3.2.2.3 Oregon Division of State Lands/Oregon Removal – Fill Law and Lower Willamette River Management Plan

The USACE and the DSL require permits for fill or removal activities that occur in waters of the state.

The DSL regulates the activity under Oregon's Removal-Fill Law (ORS 196.795-990). A permit would be required if a project included removal or fill of 50 cubic yards or more of material in waters of the state; removal or fill of material, regardless of cubic yards, in waters designated as essential salmon habitat; or removal or fill of the bed and banks of a scenic waterway. The USACE requires permits for dredging and filling activities regardless of the amount of area disturbed and/or filled. The permits are regulated by Section 10 of The Rivers and Harbors Act, and Section 404 of the Clean Water Act. Section 10 would be needed if a project required any work in or over "navigable waters" of the United States. Section 404 is similar and would require a permit for dredging or filling into "Waters of the United States". The regulatory jurisdiction is the "ordinary high water mark" that is established by fluctuating water along banks of rivers and streams.

Although the USACE administers the 404 Permitting program, EPA assumes responsibility at CERCLA sites for verifying that the substantive requirements of Section 404 of the Clean Water Act are met. This regulation is not anticipated to be applicable or relevant and appropriate because the soil cap will not impact waters of the State.

3.2.2.4 Oregon Department of Environmental Quality– Underground Injection Control Program

The Underground Injection Control (UIC) program was enacted in 1974, under the federal Safe Drinking Water Act to protect groundwater aquifers, primarily used for drinking water, from contamination. Under delegated authorization from the EPA, the DEQ regulates all underground injection in Oregon under OAR Chapter 340, Division 44.

An underground injection is any system, structure or activity that is created to place fluid below the ground or sub-surface, including industrial/commercial process & wastewater disposal into drainfields of any size and stormwater systems, such as sumps, infiltration galleries, and drywells. Under OAR 340-044-0012, businesses discharging their process wastes into sumps, drywells, septic tanks and drainfields are required to apply for authorization by rule or permit. Owners/operators of injections that do not have the potential to cause groundwater contamination may be Rule Authorized, and do not have to obtain an UIC permit (OAR 340-044-0018(1)). These parties must register the injection system and submit inventory information and additional information as needed to determine the potential for groundwater contamination. Owners/operators of an allowable injection activity that is not excluded from UIC regulation or Rule Authorized, however, must either close or modify the site to meet rule requirements, or submit a Water Pollution Control Facility permit application to the appropriate regional DEQ office before construction, maintenance, and operation (OAR 340-044-0035).

The Oregon UIC rules are anticipated to be applicable or relevant and appropriate because infiltration or detention ponds may be included in the soil cap design for stormwater management. It is anticipated that these "injections" would be considered Rule Authorized, as the infiltrating water would be drainage from cap material placed above the contaminated soil of the site.

3.2.3 Local Regulations

Although not applicable or relevant and appropriate for on-site actions under CERCLA, substantive requirements of the following local regulations will be considered to the extent feasible for the soil cap:

City of Portland

- Chapter 33.140 – Employment and Industrial Zones
- Chapter 33.440 – Greenway Overlay Zones
- Title 10 – Erosion Control
- Chapter 24.50 – Flood Hazard Areas
- Chapter 24.70 – Grading and Clearing
- Chapter 17.38 – Stormwater Management

As with development of the barrier wall and sediment cap designs, DEQ will coordinate with the City of Portland's Bureau of Development Services to ensure that these regulations are considered in designing and constructing the soil cap.

3.3 Future Land Use

The McCormick & Baxter site is zoned for heavy industrial use. Although historically the McCormick & Baxter site and adjacent properties were used for heavy industry, these properties currently lie vacant. South of McCormick & Baxter is a 34-acre parcel zoned for industrial use that was purchased in 1998 by Triangle Park LLC for potential future industrial development. The Willamette

Cove property north of McCormick & Baxter was a former industrial property that was purchased in 1996 by Metro to be restored as a riverfront greenspace. The bluff to the northeast of the UPRR tracks bordering the McCormick & Baxter site is a greenspace managed by the City of Portland. At the top of the bluff is the residential neighborhood. The University of Portland campus is located along the top of the bluff approximately ¼ mile from the McCormick & Baxter site.

The City of Portland Bureau of Planning (now the Bureau of Design Services) completed a site reuse assessment in 2001 for the McCormick & Baxter site as part of EPA's Superfund Redevelopment Initiative (City of Portland 2001). The Executive Summary of this study is included in Appendix A and the full report can be accessed on the City of Portland's web site (www.planning.ci.portland.or.us/pdf/MB_exec.pdf). An Advisory Committee, representing the property owner, nearby landowners, community organizations, and the City of Portland, was formed to develop reuse recommendations. The recommendations were based on understanding the environmental, legal, infrastructure, and economic conditions that influence the site's development potential. The Committee listed the following reuse obstacles and opportunities in its McCormick & Baxter Site Reuse Assessment Final Report:

- The private market is not likely to move the property into productive use in the near term. Development costs from contamination liability, property encumbrances, and infrastructure requirements substantially exceed market land values;
- Most uses would require access improvements estimated to cost in excess of $5 million;
- Reuse as a park could offer short-term economic advantages over other uses. For example, public acquisition through 'friendly condemnation' would establish a barrier to state and federal liability for past contamination;
- Access to the site is limited by distance from a collector street and truck route, steep grades, and railroad crossings. The local streets leading to the site, however, have adequate physical and operational capacity to accommodate modest traffic volumes, such as from industrial, residential, or multi-purpose recreation uses (generally fewer than 3,000 daily trips);
- Even lower traffic volumes (especially from trucks) would have significant negative impacts on the residential and campus environment along access streets;
- Higher intensity uses, such as community shopping center or office complex, could generate tens of thousands of daily trips and potentially overwhelm the local street system;
- Relative to other uses, a low-intensity park or open space would generate minimal traffic impact; and
- Superfund remedies were designed to adequately protect workplace and recreational uses. Residential use would require further investigation and possibly additional protective measures.

The Committee reached general agreement to recommend use of the site as "managed open space, such as a park or natural area" but was unable to resolve whether to recommend this as a permanent or interim use. Given this unresolved issue, the Committee's working agreement called for reuse recommendations by the Bureau of Planning.

The Bureau of Planning made seven recommendations to the various parties that have influence on the future use of the site. These recommendations were subsequently endorsed by the Portland City Counsel in Resolution Number 36010 adopted on July 25, 2001. Paramount of these seven recommendations is recommendation Number 1:

> *Develop the site as a permanent park to include a variety of active and passive recreation uses. Rehabilitate the riverfront as a riparian buffer, generally 100-300 feet wide, to enhance natural-resource values while accommodating opportunities for environmental education, including an interpretive trail, viewpoints, and limited access to the river. Consider developing up to one third of the site for complementary non-recreational uses that are consistent with the Advisory Committee's reuse criteria.*

The soil cap will be designed as a managed natural area consistent with the recommendations of the Land Reuse Advisory Committee. Furthermore, the soil cap will be designed, to the extent feasible, to accommodate future development of the site as a permanent park to include a variety of active and passive recreational uses and to accommodate "complementary non-recreational uses" consistent with the Advisory Committee's reuse criteria.

As a managed natural area, the cap will provide habitat benefits including:

- Stormwater will be managed to mimic a natural area with minimal use of pipes and other manufactured elements.
- Water on or entering the site will be managed to prevent runoff from causing erosion or exposing contaminants.
- Wetlands and drainages constructed for stormwater management will be located away from the most contaminated areas.
- Natural water features that exist or could be restored will be protected from adverse effects of stormwater runoff.
- Planting of native grasses, wildflowers, shrubs and hardwood species (e.g., cottonwoods, willows and oaks) native to the area will be used to help stabilize the cap and provide habitat for terrestrial species. Restoration efforts at Oaks Bottom Wildlife Refuge and the St. John's Landfill will be evaluated for information on native plant selection, ideal soil conditions and revegetation techniques.

To accommodate potential future development of the site as a permanent park to include a variety of active and passive recreational uses, the cap will provide the following elements:

- The existing ground surface will be leveled, surveyed and demarcated with a geotextile material or gravel layer prior to cap placement.
- Any areas of the cap that need to be elevated will be constructed with clean fill and not contaminated soil.
- All known subsurface features such as buried debris that may provide geotechnical constraints on future development will be surveyed and documented.

4 Soil Cap Elements

The objective of capping the site soils, as stated in the ROD, is to protect against direct contact with residual contamination, which is required because of the widespread distribution of low-level contamination in soils throughout the site. With the installation of a fully encompassing barrier wall, it is also necessary to evaluate the effects of the soil cap design on surface water infiltration. This section describes the elements of the soil cap design.

4.1 Utilities and Structures Removal

Before installation of the soil cap, existing utilities will be removed or abandoned. Fire hydrants will be removed and any associated piping will be grouted to prevent preferential flow paths. In addition, the former shop building, freight container, above ground tanks, small metal shed and backflow prevention device, and utility poles will be removed and water lines capped.

To accommodate ongoing site activities, such as NAPL recovery, groundwater monitoring and site maintenance, an office trailer and equipment storage building or container unit will be located close to the north entrance of the site. These buildings will be serviced by phone, water and electrical utilities.

4.2 Cap Boundary

The boundary of the cap will follow the McCormick & Baxter property boundaries, along the boundary of the upland area adjacent to the river. The boundary of the soil cap along the Willamette River will tie into the sediment cap boundary along the upland side of the bank regrade.

The bank at the Willamette River will be regraded during the sediment cap RA. For topographic diversity, the slope will vary from 4 horizontal (H):1 vertical (V) to 7H:1V. A terrace will split the slope and, again for diversity, vary in width and elevation. The sheet-pile wall will be cut to match the regraded bank. One-and-one-half feet of clean fill and one-half foot of topsoil will be placed on the regraded surface. Topsoil will be underlain by a geotextile demarcation layer. After topsoil placement, the slope will be hydroseeded and a turf reinforcement mat (TRM) will be placed over the seeded surface. The TRM provides a soft armoring alternative to riprap. It will be tied into the articulated concrete block at the base of the bank and keyed into the soil at the top of the bank. Additional fill, as described previously, will be placed at the top of the bank and extend 50 feet from the top of the bank towards the bluff and hydroseeded. This entire upland surface treatment extends, on average, 130 feet landward of the ordinary high water mark in order to meet the City's greenway guidelines and to provide terrestrial and aquatic habitat. Native shrubs and trees will be planted on the regraded bank after the grasses have stabilized the TRM, which is estimated to occur within one year of hydroseeding.

4.3 Materials

Several alternatives for sources of material for cap construction are being considered. Appendix B presents a table of possible sources of cap materials as well as a table of preliminary estimates of soil quantities required for the soil cap design. Included in the table are soils from the City of Portland's Alsop/Brownwood and Kelly Creek projects. A summary of the Alsop/Brownwood project, prepared by the City of Portland, is included in Appendix C. Soils from the Alsop/Brownwood project may be obtained as a result of the restoration the Johnson Creek watershed in a former agricultural area. Suitability of these soils as a source of both cap materials and topsoil will be based on geotechnical and chemical quality studies of the soils. Preliminary indications are that these soils are suitable, however, additional analyses of soils may be conducted to determine if pesticides and herbicides are present in soils. In addition, agronomy tests may be conducted to ascertain the suitability of soils as a plant substrate.

As summarized in Appendix B, in addition to the City's Alsop/Brownwood and Kelly Creek projects soils, E & E is investigating other potential sources of soil and clean fill (e.g., silt, fill sand, sandy loam, topsoil, blended soil, etc.). If not used in the soil cap itself, clean dredge sands may also be used to achieve design slopes. The slopes would then also be covered by topsoil that will sustain vegetation.

Another potential source for some of the clean fill is from the McCormick & Baxter site itself. Based on limited soil sampling and our understanding of past practices at the site, subsurface soils in the southern portion of the site may be uncontaminated. However, further sampling will be necessary to assess the suitability of using these soils as cap material.

Required soil volumes have been estimated to range between 120,000 and 180,000 cubic yards for the cap and are included in Appendix B. Minimum volume estimates are based on flat lying cap where sloping is not included. Maximum volume estimates are based on the creation of a single ridge or two ridges aligned through the center of the site.

The ROD calls for EPA and DEQ to consider alternatives for transport of soil for the cap that do not involve hauling materials through the nearby St. John's neighborhood. Consideration of alternatives for transport is on going and includes truck, rail, and barge. A railroad transport study is being conducted as part of the effort to determine if this is a viable option for soil transport to the site. Further study of alternatives for transportation of materials will be presented as a Technical Memorandum. A separate but related technical memorandum will address stockpiling of imported soils and soil handling onsite.

4.4 Possible Cap Profiles

The ROD describes a soil cap profile consisting of a 0.5-foot layer of topsoil overlying a 1.5-foot layer of soil fill overlying a 3-inch gravel demarcation layer. As stated previously, the original intention of the cap was to provide protection against direct contact with residual contamination. The ROD did not require the cap to limit infiltration of surface water. However, the 2002 ESD authorizing installation of the subsurface barrier wall required DEQ and EPA to consider the use of impermeable or semi-permeable features within the 17-acres encircled by the barrier wall.

The *Hydrologic Evaluation of Landfill Performance (HELP) Model* Version 3.07 (November 1997) was used to evaluate the effectiveness of various cap profiles on infiltration reduction. The HELP computer program is a quasi-two-dimensional hydrologic model for conducting water balance analyses of landfills, cover systems, and other waste containment facilities. The model accepts weather, soil, and design data and uses solution techniques that account for the effects of surface storage, snowmelt, runoff, infiltration, evapotranspiration, vegetative growth, soil moisture storage, lateral surface drainage, leachate recirculation (if applicable), unsaturated vertical drainage, and leakage. Following input of weather, soil, and design parameters, the model estimates the amounts of runoff, evapotranspiration, drainage, and percolation/leakage that may be expected to result from the simulated design conditions.

Using the HELP program, the following cap scenarios were modeled for a period of 5 years:

- **Scenario #1**: No cap with no vegetation or slope to serve as a baseline.
- **Scenario #2**: 24-inch, permeable cap consisting of 18 inches of compacted locally available clayey silt, overlain with 6 inches of loosely placed topsoil, vegetation, and a 2 percent slope.
- **Scenario #3**: 24-inch, permeable cap consisting of 18 inches of locally available sandy loam overlain with 6 inches of clayey silt topsoil, vegetation, and a 2-percent slope.
- **Scenario #4**: 24-inch, permeable cap consisting of 18 inches of locally available dredge sand overlain with 6 inches of topsoil, vegetation, and 2-percent slope.
- **Scenario #5**: 24-inch, impermeable cap consisting of a geosynthetic liner (i.e., bentonite mat) overlain with a drainage net, 18 inches of dredge sand, 6 inches of topsoil, vegetation, and 2-percent slope. This scenario was modeled to allow comparison with the other permeable cap scenarios.

The HELP model predicts that for the baseline scenario #1, approximately 66 percent of the 100 percent total precipitation will percolate/leak into the underlying groundwater table, 33 percent will be lost through evapotranspiration, and 0.005 percent will runoff. An increase in water storage is predicted for the remaining 0.995 percent. For the permeable vegetated cap simulations (Scenarios #2 through #4), the program predicts a decrease in percolation of approximately 13 percent for Scenarios #2 and #3; and a decrease of approximately 9 percent for scenario #4. These leakage reductions are mainly due to an increase in evapotranspiration (runoff quantities remained relatively unchanged). A more significant decrease in percolation is predicted for Scenario #5, where placement of a geosynthetic liner (and drainage layer) results in a percolation of 0.16 percent.

A report presenting the findings of the model simulations for each of the scenarios is included in this document as Appendix D.

The HELP model predicts that for the baseline scenario #1, approximately 66 percent of the 100 percent total precipitation will percolate/leak into the underlying groundwater table, 33 percent will be lost through evapotranspiration, and 0.005 percent will runoff. An increase in water storage is predicted for the remaining 0.995 percent. For the permeable vegetated cap simulations (Scenarios #2 through #4), the program predicts a decrease in percolation of approximately 13 percent for Scenarios #2 and #3; and a decrease of approximately 9 percent for scenario #4. These leakage reductions are mainly due to an increase in evapotranspiration (runoff quantities remained relatively unchanged). A more significant decrease in percolation is predicted for Scenario #5, where placement of a geosynthetic liner (and drainage layer) results in a percolation of 0.16 percent.

Based on the modeling results, very little reduction in infiltration is achieved by using a compacted silty soil instead of a uncompacted sandy soil (i.e., only a 4% reduction in infiltration between Scenarios #2 and #4). The use of vegetation (combined with grading to facilitate runoff) has a more significant effect on infiltration, although the benefits are still relatively minor (i.e., a 9% reduction in infiltration between Scenarios #4 and #1). Only the use of impermeable clays with geosynthetics provides substantial reductions in stormwater infiltration.

Given the expense and high maintenance requirements of a clay cap, the design criteria will be to minimize infiltration to the extent possible by maximizing stormwater runoff and evapotranspiration within the barrier wall area. As such, the cap soil within the barrier wall area may have different properties than the cap soil throughout the rest of the site.

The potential need for an impermeable cap over the barrier wall area will be further considered as results of the barrier wall performance monitoring become available. This work was initiated in September 2003 following construction of the barrier wall. However, as described in the *Barrier Wall Performance Monitoring Plan* (E & E, August 2003), in order to adequately document steady-state or "normal cycle" conditions and draw conclusions regarding the barrier wall's effectiveness with high certainty, the monitoring plan covers a three-year cycle to fully understand the effects of seasonal changes in groundwater flow patterns, river stage and flood patterns, and overall performance of the barrier wall.

In the event that initial monitoring results indicate the barrier wall's effectiveness is adversely compromised by surface water infiltration, additional design options will be explored to further reduce infiltration. Also, the need for an impermeable cap will be evaluated upon completion of the three year *Barrier Wall Performance Monitoring Plan*. This evaluation will be documented in the next Five-Year Review of the McCormick & Baxter site, scheduled for 2006. These periodic reviews are required by CERCLA Section 121(c) and the NCP Section 300.430(f)(4)(ii). If it is concluded that an impermeable cap is needed, DEQ and EPA will issue a ROD Amendment or ESD.

4.5 Stormwater Management

To accommodate future use of this site as a natural area, as discussed in Section 3.3, surface water will be managed to mimic a natural area with minimal use of pipes and other manufactured elements, and it is envisioned that natural water features will be designed into the soil cap. These natural water features will need to be protected from adverse effects of stormwater runoff. Also, as discussed in Section 4.4, surface water will be managed within the 17-acre barrier wall area to minimize infiltration.

Stormwater management will be necessary to reduce the potential for erosion of the soil cap and unintentional pooling of surface water as well as to route surface water away from the 17-acre barrier wall area. In addition to slope, several factors are being considered for managing stormwater in the cap design including use of an infiltration pond or ponds as well as a spillway. The infiltration pond would slow the flow of stormwater runoff to the river by collection of stormwater in the pond that might otherwise flow over the riverbank directly to the river. Stormwater would then slowly infiltrate the soils lining the infiltration pond. The City of Portland Bureau of Environmental Services (BES) *Stormwater Management Manual* will be used for the design.

4.6 Vegetation

To accommodate future use of this site as a natural area, as discussed in Section 3.3, planting of native grasses, wildflowers, shrubs and hardwood species (e.g., cottonwoods, willows and oaks) native to the area will be used to help stabilize the cap and provide habitat for terrestrial species. Restoration efforts at Oaks Bottom Wildlife Refuge and the St. John's Landfill will be evaluated for information on native plant selection, ideal soil conditions and revegetation techniques.

To maximize evapotranspiration within the barrier wall area, the optimal selection of native species will be evaluated with results and recommendations provided in a Vegetation Management Strategy, Plantings Plan and Vegetation Maintenance and Monitoring Plan.

4.7 Operations and Maintenance Provisions

The ROD calls for long-term monitoring of the soil cap. Long-term monitoring of the soil cap will be achieved by regular visual inspections for indications of erosion of the cap or breaching by animal burrows or human vandalism. Indications of erosion of the cap may include stressed vegetation as well as unusual pooling of surface water. If cap erosion or breaching is identified during monitoring, repairs will be conducted in a timely manner to ensure the integrity of the cap is maintained.

In addition, the catch basins that are part of the surface water collection system will need annual inspection and occasional cleaning. Monitoring and maintenance of the native vegetative cover also will be necessary.

During design of the soil cap, a conceptual long-term Monitoring and Maintenance Plan will be prepared.

4.8 Access

Access roads will be included in the soil cap design for operations and maintenance activities associated with all aspects of the RA (groundwater, sediment, and soil). The existing asphalt near the entrance will be left in place and/or possibly upgraded as part of the construction of access roads. Roads will be designed to access NAPL extraction well, compliance point monitoring wells and to facilitate maintenance.

To prevent vandalism and illegal garbage disposal, which has been a constant problem at the unfenced Willamette Cover site, the McCormick and Baxter site will remain fenced following construction of the soil cap. However, along the river the fence will be located landward of the Willamette River Greenway.

4.9 Monitoring and Extraction Wells

The ROD calls for special provisions, if necessary, for placement of the cap around monitoring or extraction wells. As part of the soil cap design, the existing site wells will be evaluated to determine which wells, if any, could be abandoned without impacting the monitoring and NAPL extraction requirements of the groundwater remedy. Wells that are not abandoned will be modified to account for the increased fill.

4.10 Schedule

DEQ and EPA have committed to completing construction of the soil cap by September 2005. Because an extremely large volume of clean fill is needed for the soil cap, it will be necessary to begin stockpiling soil as early as October 2004 with the goal of obtaining half of the soil cap material (~100,000 cubic yards) prior to April 2005. Construction of the soil cap will either occur as the soil is received (beginning in October 2004) or will begin in April 2005 (after a substantial portion of the soil has been stockpiled). A detailed construction schedule will be developed over the next several months as the source of capping soil and transportation options for delivering this soil are better determined.

The soil cap design is expected to be finalized by September of 2004. A Prefinal Design will be available by May or June 2004 for review by the project team, Trustees, Tribes, City of Portland and other stakeholder. Input on the Prefinal Design will be considered by DEQ in finalize the design.

Supporting documents that will be prepared over the next four months as the soil cap design is developed include:

- Soil Cap Design Criteria Report addendum (response to comments).
- Technical Memorandum on suitability of on-site soils from southern portion of site for cap material.
- Technical Memorandum on transportation options for capping material.
- Technical Memorandum on stockpiling and handling of imported soils.
- Construction Schedule and Cost Estimate.
- Vegetation Management Strategy, Plantings Plan and Vegetation Maintenance and Monitoring Plan.
- Conceptual Monitoring and Maintenance Plan.
- Biological Assessment Addendum (Draft).
- Clean Water Act Section 401 Water Quality Certification (Draft).
- Substantive Compliance with Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act (Draft; if applicable or relevant and appropriate to the cap design).

Input on this Soil Cap Design Criteria Report will be used by DEQ to prepare the Prefinal Design.

4.10 Cost

The cost estimate for the soil cap provided in the 1996 ROD and adjusted for inflation is $4,000,000. However, this amount, although adjusted for inflation, is based on estimates developed in the 1995 Revised Feasibility Study. Due to the dated nature of this estimate, the uncertainty is rather high. A revised cost estimate will be prepared as part of the Prefinal Design.

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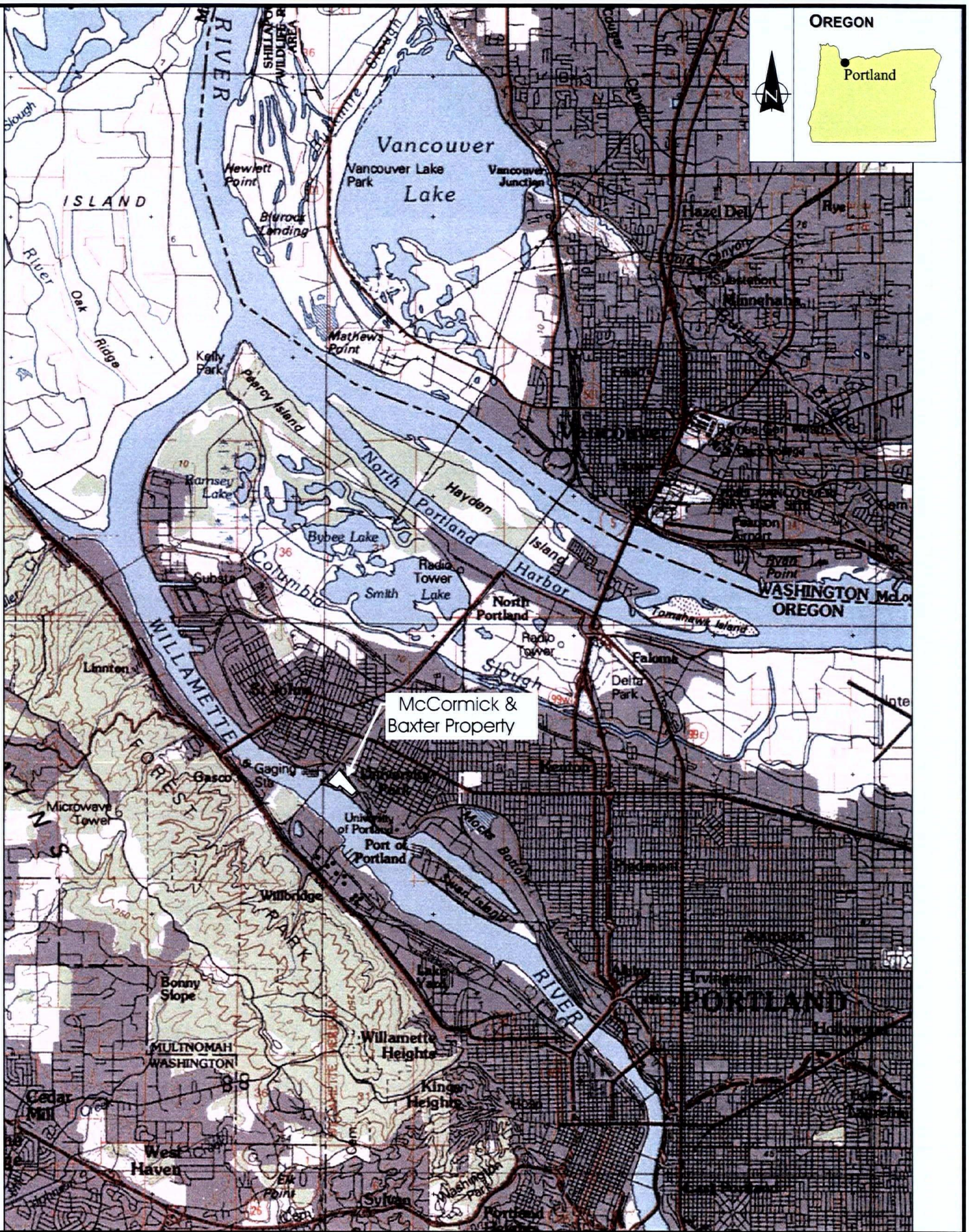

ecology and environment, inc.
International Specialists in the Environment
Portland, Oregon

McCORMICK AND BAXTER CREOSOTING COMPANY SITE
Portland, Oregon

Figure 1

SITE LOCATION MAP

Date: 2-4-04

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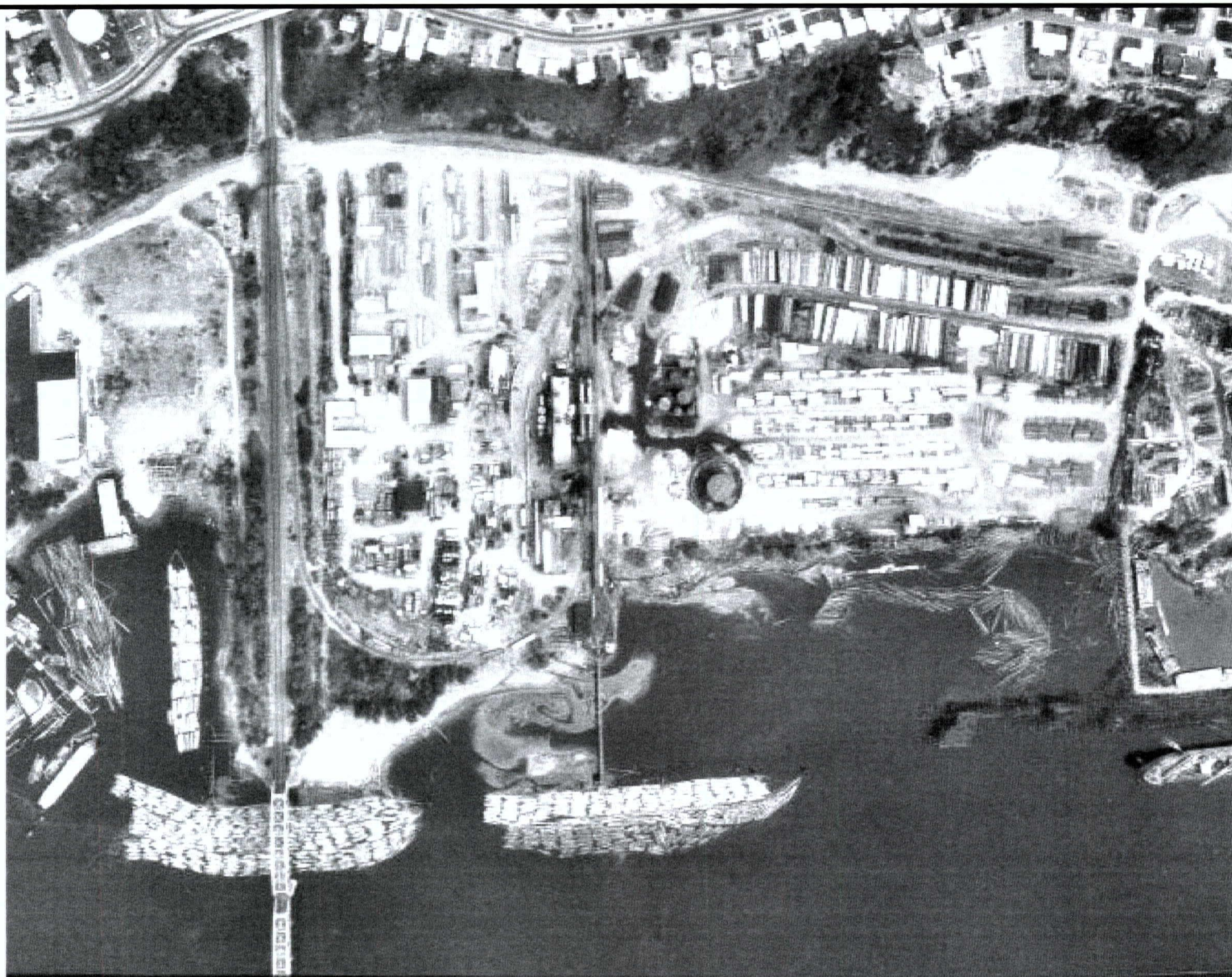

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Seattle, Washington

McCORMICK AND BAXTER CREOSOTING COMPANY SITE Portland, Oregon	Figure 2 1973 AERIAL PHOTO	
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International Specialists in the Environment
Seattle, Washington

SPMD Sample Locations from OSU Report
Aerial Photo: EPA Region 10 - 2002

McCORMICK AND BAXTER
CREOSOTING COMPANY SITE
Portland, Oregon

Figure 3
Barrier Wall Alignment

Date:	Drawn by:	Job number:
02/06/04	AVH	001688.OY02.27.01

A

Executive Summary – Site Reuse Assessment (City of Portland)

McCormick & Baxter

Site Reuse Assessment: Final Report

City of Portland
Bureau of Planning

June 2001

RIVER
RENAISSANCE

For more information about this project, please contact

Steve Kountz, City Planner
503-823-4551
skountz@ci.portland.or.us

Copies of this report are available at

City of Portland
Bureau of Planning
1900 SW 4th Avenue, Suite 4100
Portland, Oregon 97201
503-823-7700

www.planning.ci.portland.or.us

Acknowledgements

Mayor Vera Katz, Commissioner in Charge
Gil Kelley, Planning Director

Project Staff
Steve Kountz, City Planner, Project Lead
Sallie Edmunds, Team Leader
Lee Rahr, Community Service Aide

U.S. Environmental Protection Agency
Alan Goodman, McCormick and Baxter Project Manager

Project Facilitator
Elaine Hallmark, Hallmark Pacific Group

McCormick and Baxter Site Reuse Advisory Committee
Pam Arden, 40 Mile Loop Land Trust, Portland Audubon Society
Nancy Chase, Metro Parks and Greenspaces
Cathy Crawford, University Park Neighborhood Association
Mike Fitz, North Portland Business Association
Tom Finlayson, Alex Jones, Greg Babcock, Mark Flatner, residential neighbors
Ron Hernandez, WAKE UP
Dr. Roy Heynderickx, University of Portland
Tom Kloster, Friends of North Beach
Charlie McCormick, McCormick and Baxter Creosoting Co.
Michael Ogan, Portland Development Commission
Shirley Schiller, Edgewater Condominium Association
Steven Shain, Triangle Park LLC
Deborah Stein, City of Portland
John Trumbull, Union Pacific Railroad
Bev Wilson, Friends of Cathedral Park Neighborhood Association

Technical Advisors
Robert Bernstein, Consulting Transportation Engineer/Planner
Jan Betz, Portland City Attorney's Office
William Dana, Oregon Department of Environmental Quality
Rob Ede, Hahn and Associates
Eric Hovee, E.D. Hovee and Company
Charles Landman, Oregon Department of Environmental Quality
George Lozovoy, Portland Bureau of Parks and Recreation
John O'Donovan, Portland Bureau of Environmental Services
Kevin Parrett, Oregon Department of Environmental Quality
Laurel Wentworth, Portland Office of Transportation
David Yamashita, Portland Bureau of Parks and Recreation

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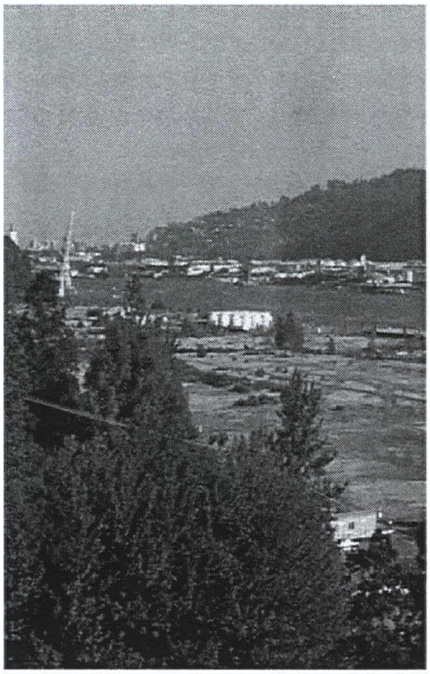
Executive Summary

A major public investment in the McCormick & Baxter Superfund Project in North Portland is nearing completion. The clean-up remedies are expected to be in place in 2003. Once safe for reuse, the site offers a rare opportunity to reclaim 50 acres of urban waterfront in the context of Portland's River Renaissance.

Redevelopment of the site also presents many complex challenges:

- What is the future of the surrounding North Beach waterfront (between University of Portland and Cathedral Park), that was historically industrial and is now mostly vacant or in public use? This area is part of the finite land supply available for harbor industrial growth, but it is constrained by marginal truck access and infrastructure needs.
- How do we return this Superfund site to beneficial use after more than $20 million of public clean-up expense? The site is potentially a test case for what will become of the most challenging among the 40-70 properties in the harbor Superfund clean-up project now getting underway.
- How will the future use relate to the residential neighborhood at the top of the adjacent bluff? The potential for positive or negative impacts on these areas is high.
- What are the opportunities at this site to meet the expanding needs for riverfront habitat restoration, recreation, public access, and sustainable development?



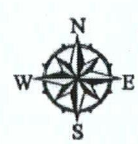
View of the McCormick and Baxter site from Waud Bluff.

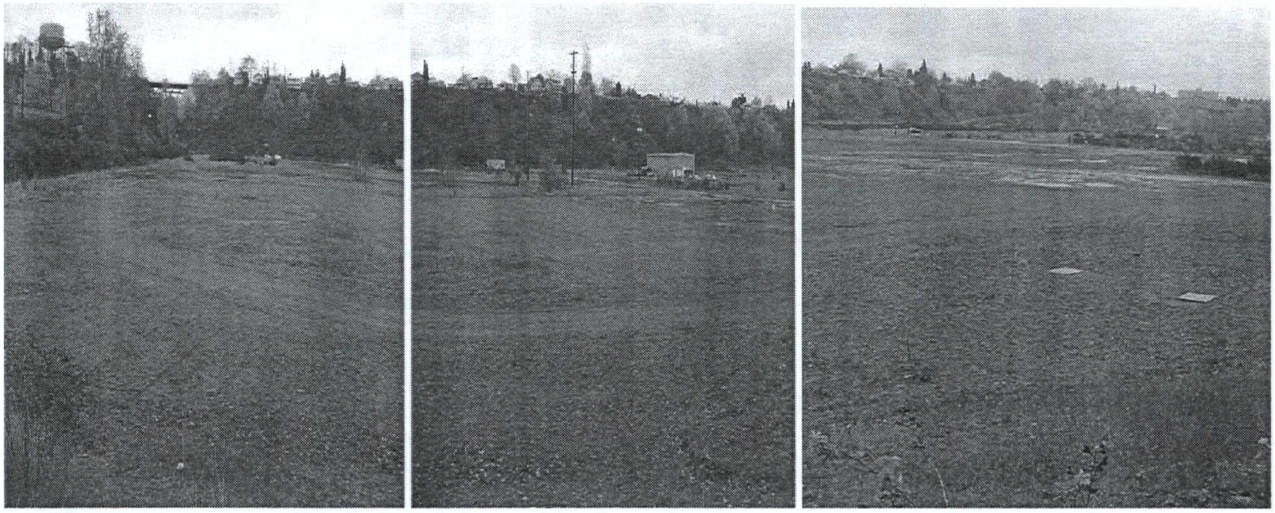
This report relates the progress and recommendations of a reuse assessment project for the McCormick and Baxter site. The City of Portland Bureau of Planning coordinated the project under contract with the U.S. Environmental Protection Agency (EPA). The reuse assessment is one of ten pilot projects being implemented around the country to launch EPA's Superfund Redevelopment Initiative.

About the Site

McCormick and Baxter Creosoting Company used the site as a wood-treatment facility for nearly 50 years and continues to own the property. The site has remained vacant since the company ceased operations in 1991. Wood-treatment operations resulted in contamination of soils, groundwater, and river sediments. In 1987, the Oregon Department of Environmental Quality (DEQ) entered into a Stipulative Order with the company requiring corrective actions. After further environmental investigation, EPA listed the property as a Superfund site in 1994. A multi-year clean-up project, led by DEQ under an agreement with EPA, is underway.

Figure 1. McCormick & Baxter Site and Vicinity





Panoramic view of McCormick and Baxter site.

The riverfront site, approximately 50 acres in size, is situated at the base of a steep bluff (see Figure 1). The immediate industrial area, which is zoned for heavy industrial use, is relatively isolated. It consists of two vacant properties: this one and a 34-acre parcel purchased by Triangle Park LLC in 1998 for future industrial development. Willamette Cove, a former industrial property directly north of the McCormick and Baxter site, was purchased by Metro in 1996 to be restored as a riverfront greenspace. Two railroads abut the McCormick and Baxter site: the (Burlington Northern Sante Fe) Railroad Bridge and a Union Pacific spur line along the base of the bluff. Access to the site is by Edgewater Street and Van Houten Place, two streets that ascend the bluff and serve the residential neighborhood.

Approach of the Project

The key elements of the approach were to (1) analyze the site's redevelopment potential, (2) engage stakeholders and the interested public in learning about, proposing, and jointly considering what uses would best fit the site; and (3) develop reuse recommendations. Chapter 1 describes these elements further. All apparent reuse options were considered, regardless of existing zoning regulations.

A team of consultants and inter-bureau staff prepared a series of reports on environmental constraints, market feasibility, transportation needs, legal requirements, and other factors pertinent to the site's future use. Their work was compiled in a companion document, the *McCormick & Baxter Reuse Assessment Project: Background Report*. Chapter 2 below summarizes this technical analysis.

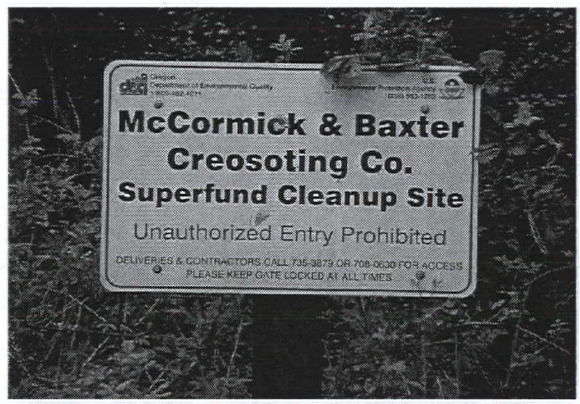
The McCormick and Baxter Site Reuse Advisory Committee was organized to discuss and develop reuse recommendations for the site. The Committee represented a broad range of stakeholder interests, including the property owner, nearby landowners, community organizations, and the City of Portland. The Committee met eleven times between February 2000 and April 2001. It developed a working agreement in March 2000, which included an understanding that its reuse recommendations would be made by consensus. In the event that the Committee could not reach consensus, the agreement called for a Bureau of Planning recommendation that gives consideration to the differing perspectives of Committee members. The Bureau of Planning also held informal open houses and other outreach activities for neighbors and interested citizens to learn about and participate in this process.

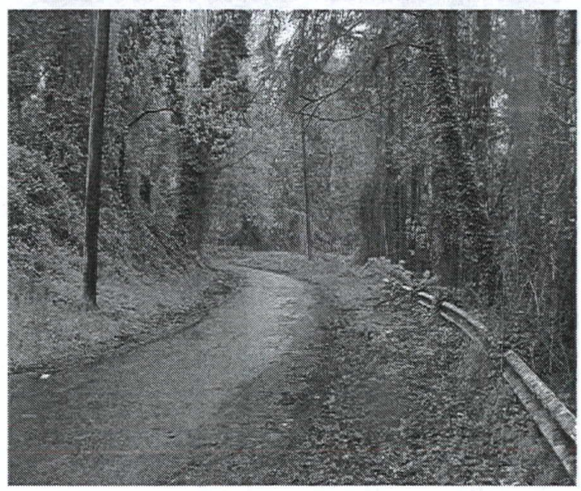
The Committee took the following steps to develop reuse recommendations:

- Understand the environmental, legal, infrastructure, and economic conditions that influence the site's development potential.
- Incorporate each other's concerns into a list of reuse criteria that would support consensus recommendations.
- Propose and discuss a range of reuse ideas and site plans.
- Select three to four reuse scenarios for public review and further study.
- Propose and discuss reuse recommendations that the entire Committee would support.
- Attempt to develop consensus recommendations.

Reuse Obstacles and Opportunities

- The private market is not likely to move the property into productive use in the near term. Development costs from contamination liability, property encumbrances, and infrastructure requirements substantially exceed market land values.
- Most uses would require access improvements estimated to cost in excess of $5 million.
- Reuse as a park could offer short-term economic advantages over other uses. For example, public acquisition through 'friendly condemnation' would establish a barrier to state and federal liability for past contamination.
- Access to the site is limited by distance from a collector street and truck route, steep grades, and railroad crossings. The local streets leading to the site, however, have adequate physical and operational capacity to accommodate modest traffic volumes, such as from industrial, residential, or multi-purpose recreation uses (generally less than 3,000 daily trips).
- Even lower traffic volumes (especially from trucks) would have significant negative impacts on the residential and campus environment along access streets.
- Higher intensity uses, such as a community shopping center or office complex, could generate tens of thousands of daily trips and potentially overwhelm the local street system.





Existing access to the site via Edgewater Street.

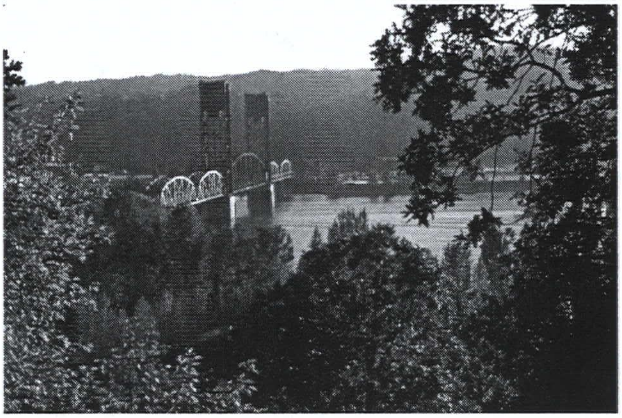
- Relative to other uses, a low-intensity park or open space would generate minimal traffic impact.
- Superfund remedies were designed to adequately protect workplace and recreational uses. Residential use would require further investigation and possibly additional protective measures.

Reuse Criteria and Scenarios Considered

What would make some uses better than others on this site? The Committee incorporated their concerns on this subject into a list of reuse criteria. Individual Committee members did not necessarily support, nor give equal weight to, each criterion. However, the Committee as a whole recognized that, in order to have the support of the full range of stakeholders, any development would require a reasonable balance of these criteria.

- Minimize traffic impacts.
- Minimize nuisance impacts.
- Minimize conflicts with industrial neighbors.
- Ensure adequacy of infrastructure.
- Get return on public clean-up investment.
- Be compatible with clean-up remedies.
- Minimize pollution impacts.
- Protect, enhance and restore fish and wildlife habitat.
- Increase public access to the river and neighborhood connections.
- Foster aesthetic quality.
- Foster efficient use of land.
- Serve an identified market or community need.
- Be consistent with the Comprehensive Plan.
- Reserve land for river-dependent or river-related uses.

Land use transition in the North Beach area: scrapyard and townhouses.



Willamette Cove, a Metro 'greenspace' directly north of the McCormick and Baxter site.

These criteria were used to evaluate alternative land use types, as described in Chapter 3. Park, athletic field, and open space uses, in general, were found to be more consistent with the criteria than other uses, although the impacts of specific development proposals would vary.

Committee members presented and discussed a variety of reuse ideas and conceptual site plans (see Appendix 3). The Commitee selected four reuse scenarios for further study and review at public open houses: an open space demonstration site, recreational use, industrial use, and mixed use (residential, commercial, and university facilities). Project consultants prepared market feasibility and traffic analysis reports for these four scenarios, which are included in Chapter 4.

The Committee was clearly divided on the acceptability of some uses. For example, while residential development may be economically viable in the short run, it would pose potential conflicts with future industrial use on the adjacent Triangle Park LLC site, and some stakeholders would not support a recommendation for residential use of the property. Also, while the City's zoning and comprehensive plan support heavy industrial use, much of the Committee objected to industrial use, citing truck traffic, pollution, and nuisance concerns.

Portland Parks and Recreation's *2020 Vision Plan Discussion Draft* (February 2001) identifies the McCormick & Baxter property as a potential site for a river park and sports fields. A growing community need exists for active and passive recreational areas. The site could be an important addition to Portland's park system. The riverfront setting, adjacent open spaces, intersecting trails, size, level terrain, and location between the St. Johns Town Center and University of Portland are well suited for use as recreational open space. A McCormick and Baxter park, located next to Willamette Cove and Waud Bluff and near Cathedral Park, would give North Portland neighborhoods an expansive riverfront amenity, comparable to the Oaks Bottom and Sellwood Park area in Southeast Portland. In a 1998 community survey for the *North Beach Vision and Action Plan*, 88% of the 354 respondents favored 'recreation' as the most appropriate use for the North Beach riverfront.

Reuse Recommendations

In July 2000, the Committee reached general agreement to recommend use of the site as managed open space, such as a park or natural area, but in the following months was unable to resolve whether to recommend this as a permanent or interim use. The property owner representative proposed a long-term lease of the site as an active park, to be reconsidered when other redevelopment options become feasible. Some Committee members supported this proposal, while others recommended securing permanent use of the site as a public park or other managed open space. Given this unresolved issue, the Committee's working agreement called for reuse recommendations by the Bureau of Planning. The decision-making process is described in Chapter 5.

As an inter-bureau representative of the City of Portland, the Bureau of Planning makes the following recommendations to the various parties that will have influence on the future use of the site. These parties include the property owner, DEQ, EPA, Portland City Council, and others.

1. Develop the site as a permanent park to include a variety of active and passive recreation uses. Rehabilitate the riverfront as a riparian buffer, generally 100-300 feet wide, to enhance natural-resource values while accommodating opportunities for environmental education, including an interpretive trail, viewpoints, and limited access to the river. Consider developing up to one third of the site for complementary non-recreational uses that are consistent with the Advisory Committee's reuse criteria.

2. The City of Portland should prepare a feasibility study to evaluate the costs and benefits of acquiring and developing the site as a park. Cost analysis should include predevelopment site management, access and infrastructure improvements, development and maintenance costs, and riparian habitat restoration. The study should include a funding strategy to develop the site, acquisition steps, and a preliminary phasing plan for development.

3. If the study finds that the site can be feasibly acquired and developed as a city park and possibly other complementary uses—and subject to approval by Portland Parks and Recreation (PP&R), City Council, the property owner, and lienholders—the site should be transferred to the City of Portland for use as a park. The acquisition agreement should provide a barrier from liability for existing site contaminants. It is PP&R's position that public use be allowed only after the site is developed as a park. The site is not considered to be a park simply by acquiring the property; rather, the site needs to be developed according to an approved master plan.

4. DEQ and EPA should forego monetary reimbursement by the City of Portland for investigation and clean-up costs, because of the site's severe development constraints and the resulting public benefits of park use. Support opportunities to fund natural resource enhancements on the site as mitigation for environmental damages under the harbor Superfund project.

5. The Division of State Lands should forego monetary reimbursement for river encroachment by historic fill below the 1859 waterline, because of this site's contamination-related constraints to removing that fill and the public benefits of park use.

6. To the extent feasible, DEQ and EPA should incorporate eventual bank contouring, landscaping, stormwater management, and habitat restoration into the design and materials of the soil and sediment caps, in order to reduce public site costs and disruption of the caps once in place. (See the advisory letters from the Portland ESA Program (5/22/01) and U.S. Fish and Wildlife Service (8/28/00)).

- Bank treatment should accommodate habitat functions and stormwater infiltration, in addition to isolating contaminants and stabilizing the cap. Treatment options that provide habitat benefits include configuring natural "roughness" or coves in the bank-line, laying back the bank, terracing above and below the waterline, and reintroducing a diversity of native vegetation including large hardwood species.
- Implement a stormwater management plan during cap installation to prevent runoff from causing erosion or exposing contaminants.
- Plant and maintain native vegetation over the riparian and upland portions of the site to stabilize the cap, enhance habitat functions, and allow for development of park uses.
- To the extent feasible, use soil mixes that would support revegetation, riparian tree cover, and upland athletic fields and structures.

7. After completion of Superfund remedies, the site should be managed to provide for security, safety, and general maintenance.

B

Preliminary Evaluation of Soil Sources and Volume Estimate

In an attempt to identify alternative sources for cap material, E & E contacted the following quarries and companies:

- Naito Properties, Portland, Oregon;
- Glacier NW, Scappoose, Oregon;
- Ross Island Sand and Gravel, Portland, Oregon;
- Morse Bros, Portland, Oregon;
- Endicott Ron Topsoil, Tualatin, Oregon;
- Grimms Fuels, Sherwood, Oregon; and,
- Waste Management, Hillsboro, Oregon;

The following describes E & E findings. Information was provided during phone conversations conducted from January 19 to January 28, 2004.

Naito Properties. E & E followed up on a report to DEQ that Naito Properties is planning a project that could generate approximately 61,000 cubic yards of fill that could be used for the soil cap at McCormick and Baxter. The project site is located on the west side of the Willamette River near the Broadway Bridge. The fill will be generated from the excavation for the construction of an underground parking lot. The project is planned to take place mid to late 2004 and is primarily waiting for approval and permits before it can begin. Site soils are fill down to approximately 10 feet with silt and sand underneath. Approximately 500 cy of the soil was identified as contaminated and will require special handling. Other parties may be interested in this fill material so it may not be available during soil cap construction.

Glacier NW. Glacier NW indicated that they could probably supply sufficient volume if the cap was fill sand. They are opening a new pit in Scappoose and they have a pit in Linnton just north of the St. Johns Bridge on the west side of the Willamette River. All the material could be barged. Glacier NW was unable to provide a quote because of time constraints regarding the sediment cap bids.

Ross Island Sand and Gravel. E & E attempted to contact Ross Island Sand and Gravel several times requesting product information and pricing regarding the soil cap materials. On January 27, 2004, E & E was able to discuss the project and request information. Ross Island indicated they would provide gradation information for their fill sand, and pricing for trucking and barge. The contact person with Ross Island also indicated that they are considering setting up for rail capabilities.

Morse Bros. Morse Bros indicated that they have sufficient volume of sandy loam at Deer Island near St. Helens and that it was conceivable to barge this material. Additionally, they have sufficient quantities of sand for the soil cap. The sales representative indicated that he would not be able to provide pricing information until January 30, 2004 or the following week.

Endicott Ron Topsoil. A phone conversation with Grimms Fuels indicated that Endicott Ron Topsoil may have sufficient quantities of sandy loam soil for the soil cap. E & E attempted to contact Endicott Ron Topsoil several times but was unable to speak with a person who could provide product and price information.

Grimms Fuels. E & E spoke to Grimms Fuels about source material, particularly topsoil, for the soil cap. They do not have or know of anyplace that would have such a large volume of "true topsoil". They suggested that a blended soil would be similar to topsoil, which would consist of a sandy loam material mixed with compost. Grimms Fuels maintains enough compost that it would be feasible for them to supply sufficient quantities to use compost for a blended topsoil.

Waste Management. E &E inquired about clean fill that comes to their landfills that might be used as a soil cap source material at McCormick and Baxter. Waste Management explained that typically they use clean fill as part of the operation of the landfill. They explained further that under certain circumstances they will sell some of the fill but only if it is to their benefit. The contact person suggested contacting trucking and construction companies to ask about any large excavation projects that might take place in 2005. Discussions with Waste Management indicated that they were aware of approximately 125,000 yards of soil at 9th and Lovejoy in Portland that need to be hauled away. They did not have a contact person regarding the fill.

E & E will continue to assess the different source options as the project develops. E & E anticipates obtaining costs for different soil types, particularly sand and sandy loam, and associated cost for feasible modes of transportation to the McCormick and Baxter site.

Minimum Fill Material For Soil Cap

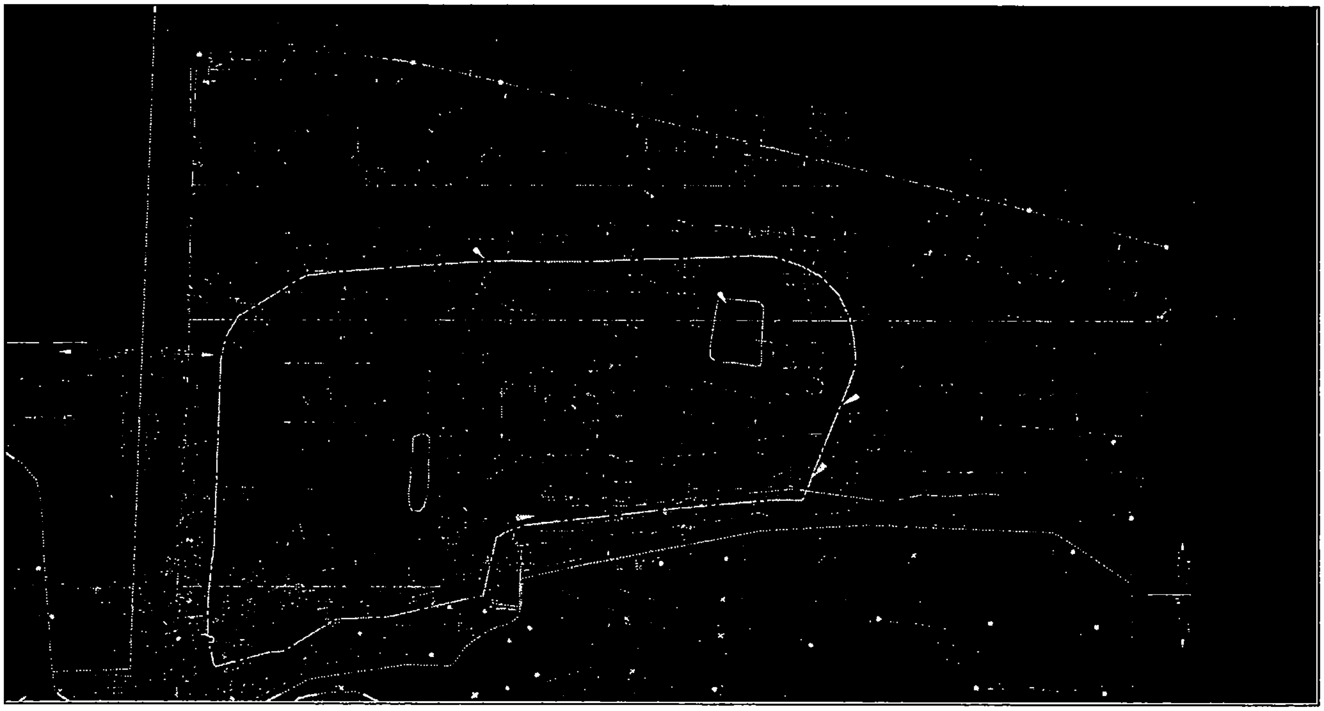
GRID	Length	Width	Area	Fill Depth (No Slope)	Fill Volume (No Slope)	Fill Volume (No Slope)	Topsoil Depth	Topsoil Volume	Topsoil Volume
	ft.	ft.	sq. ft.	ft.	cu. ft.	cu. yds.	ft.	cu. ft.	cu. yds.
A1	490	280	137,200	1.5	205,800	7,622	0.5	68,600	2,541
A2	490	291	142,590	1.5	213,885	7,922	0.5	71,295	2,641
A3	490	291	142,590	1.5	213,885	7,922	0.5	71,295	2,641
A4	504	284	143,136	1.5	214,704	7,952	0.5	71,568	2,651
B1	485	127	92,150	1.5	138,225	5,119	0.5	46,075	1,706
	485	126							
B2	485	291	141,135	1.5	211,703	7,841	0.5	70,568	2,614
B3	485	291	141,135	1.5	211,703	7,841	0.5	70,568	2,614
B4	203	153	15,530	1.5	23,294	863	0.5	7,765	288
C1	485	127	30,798	1.5	46,196	1,711	0.5	15,399	570
C2	485	291	141,135	1.5	211,703	7,841	0.5	70,568	2,614
C3	485	258	125,130	1.5	187,695	6,952	0.5	62,565	2,317
D2	471	130	106,607	1.5	159,911	5,923	0.5	53,304	1,974
	472	161							
D3	472	247	116,584	1.5	174,876	6,477	0.5	58,292	2,159
Total (Calculated) =			1,475,719			81,984			27,328
Total (From CAD) =			1,451,558			80,642			26,881

Percent Difference = 2% OK

Grade = 2%						
GRID	Length	Width	Fill Depth (2% Slope)	Volume (2% Slope)	Volume (2% Slope)	
Units	ft.	ft.	ft.	cu. ft.	cu. yds.	
A1	490	280	5.6	384,160	14,228	
A2	490	291	9.8	698,691	25,877	
A3	490	291	9.8	698,691	25,877	
A4	504	284	5.7	406,506	15,056	
B1	485	127	4.9	156,813	5,808	Calculated by average end area method.
	485	126				
B2	485	291	10.7	756,484	28,018	
B3	485	291	7.76	547,604	20,282	
B4	203	153	1.94	9,880	366	Calculated by average end area method.
C1	485	127	2.5	41,000	1,519	Calculated by average end area method.
C2	485	291	8.4	589,944	21,850	
C3	485	258	5.2	322,835	11,957	
D2	471	130	5.6	227,328	8,420	Calculated by average end area method.
	472	161				
D3	472	247	4.9	287,962	10,665	
Total (Calculated) =					189,922	

Estimated Bank Volume (Fill and Topsoil) = 299,235 cu. Yds.

Bank volume does not include swell. Add 12% for sand and 25% for loam.



McCormick & Baxter Soil Cap/Fill Estimate

	Area: SF	SY	Acres	Layer Depth: Feet	Bank Volume: CY	Grade Factor[1] %	Additional Volume CY	Swell[2] %	Swell Volume CY	Loaded Volume CY
Volume No. 1 (No Slope)										
Soil Fill (Loam)	1,451,558	161,284	33.3	1.5	80,642	0%	0	25%	20,161	100,803
Topsoil	1,451,558	161,284	33.3	0.5	26,881	0%	0	1%	269	27,150
Volume No. 2 (With Slope)										
Soil Fill (Loam)	1,451,558	161,284	33.3	1.5	80,642	50%	40,321	25%	20,161	141,124
Topsoil	1,451,558	161,284	33.3	0.5	26,881	50%	13,440	1%	269	40,590
Volume No. 3 (No Slope)										
Soil fill (Sand)	1,451,558	161,284	33.3	1.5	80,642	0%	0	12%	9,677	90,319
Topsoil	1,451,558	161,284	33.3	0.5	26,881	0%	0	1%	269	27,150
Volume No. 4 (With Slope)										
Soil fill (Sand)	1,451,558	161,284	33.3	1.5	80,642	50%	40,321	12%	9,677	130,640
Topsoil	1,451,558	161,284	33.3	0.5	26,881	50%	13,440	1%	269	40,590

[1]Assume site grading for runoff will add 50% more cap material.

[2]Swell factors from Table 13.10, page 13.16, Standard Handbook for Civil Engineers, Fourth Edition. Assume topsoil will have minimum compaction.

Determine additional volume needed per cell to maintain 2-ft of cap cover and 2% slope as shown on drawing

Cell Dimension	
L (ft) =	226.00
W (ft) =	282.50
Cap thickness (ft) =	2.00
Cap Volume per cell (cu.ft.) =	127,690.00
Cap Volume per cell (cu. Yds.) =	4,729.26

To determine additional for drainage slope, use average end area method.

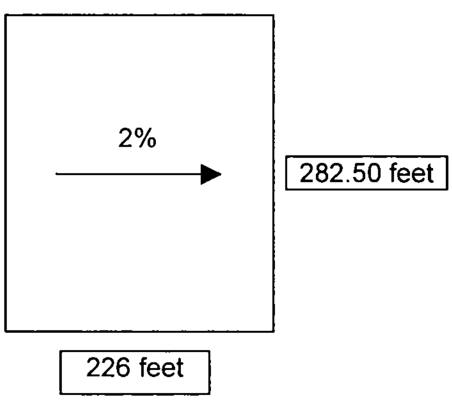
A1 =	399.03
A2 =	1,675.93
Aavg =	1,037.48

Additonal Volume per cell for slope = Aavg*Length

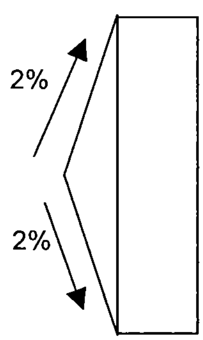
Volume (cu ft) =	234,470.76
Volume (cu yds) =	8,684.10

Assume a minimum of 6 cells

Additional volume for 6 cells =	52,104.61
For sand add 12% swell	6,252.55
Total additonal using sand =	58,357.17
For loam add 25% swell	13,026.15
Total additonal using loam =	65,130.77



PLAN



PROFILE

C

Alsop/Brownwood Salmon Habitat Restoration Summary

Alsop/Brownwood Salmon Habitat Restoration

***Project Benefits*:**
Removing the fill to reconnect the creek to its historic floodplain and to create off-channel habitat will significantly improve fish and wildlife habitat. These actions will also reduce frequent flooding by attenuating high flows. In addition, the experience and knowledge gained will be used on other restoration sites throughout the Portland area and beyond.

***Description of area*:**
Lower Powell Butte is located at the southeast edge of Portland, OR near the confluence of Kelley Creek. The site forms the SE boundary of the Powell Butte 542-acre natural area. Johnson Creek, which runs through the middle of the site, is home to an independent population of federally-listed salmon.

Johnson Creek is one of the last free-flowing streams in the Portland area. It is impacted by urban development, industrial land use, and historic agricultural practices. Sections of Johnson Creek flood, on average, every other year. The flood of February 1996 caused almost $5 million in damages. This project will improve conditions in the creek and its floodplain.

Project status and cost:
The Portland City Council, federal agencies, and the public support the project. Design has commenced, however, permits have not been secured. The time needed to obtain permits is estimated at nine months. Total cost is $7.1 million.

***Partners*:**
National Oceanic and Atmospheric Administration--$75,000 (confirmed). US Army Corps of Engineers Section 206--$5 million (proposed). The OR Watershed Enhancement Board provided $655,000 for the adjacent Kelley Creek Restoration project. The City will fund the balance.

1/14/2004

D HELP Modeling Report

Hydrological Evaluation of Landfill (HELP) Modeling Report

McCormick & Baxter Creosoting Co. Site Portland, Oregon

February 2004

Prepared for:

OREGON DEPARTMENT OF ENVIRONMENTAL QUALITY
811 Southwest Sixth Avenue
Portland, Oregon 97204

Prepared by:

ECOLOGY AND ENVIRONMENT, INC.
333 SW Fifth Avenue
Portland, Oregon 97204

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Attachments

HYDROLOGICAL EVALUATION OF LANDFILL PERFORMANCE (HELP) MODELING REPORT

McCORMICK & BAXTER CREOSOTING CO. SITE PORTLAND, OREGON

1 Introduction

The Oregon Department of Environmental Quality (ODEQ) has elected to implement a removal action involving capping of the upland portion of the McCormick and Baxter site where soil contaminant concentrations exceed background concentrations and health-based protective levels. As described in the Record of Decision (ROD; EPA/DEQ 1996), the purpose of the cap is to protect against direct contact with residual contamination. The ROD indicates that an impermeable cap (e.g., RCRA cap) is not required. The ROD further states that the cap will consist of layers of soil covered with a layer of topsoil and be vegetated. The cap will also include a storm water collection system to reduce the potential for erosion or pooling of surface water.

The *Hydrologic Evaluation of Landfill Performance (HELP) Model* Version 3.07 (November 1997) was used to evaluate the cap design. The HELP computer program is a quasi-two-dimensional hydrologic model for conducting water balance analyses of landfills, cover systems, and other waste containment facilities. The model accepts weather, soil, and design data and uses solution techniques that account for the effects of surface storage, snowmelt, runoff, infiltration, evapotranspiration, vegetative growth, soil moisture storage, lateral surface drainage, leachate recirculation (if applicable), unsaturated vertical drainage, and leakage. Following input of weather, soil, and design parameters, the model estimates of the amounts of runoff, evapotranspiration, drainage, and percolation/leakage that may be expected to result from the simulated design conditions.

Using the HELP program, the following cap scenarios were modeled for a period of 5 years:

- Scenario #1: No cap with no vegetation to serve as a baseline.
- Scenario #2: 24-inch, permeable cap consisting of 18 inches of compacted locally available clayey silt, overlain with 6 inches of loosely placed topsoil and vegetation.
- Scenario #3: 24-inch, permeable cap consisting of 18 inches of locally available sandy loam overlain with 6 inches of clayey silt topsoil and vegetation.
- Scenario #4: 24-inch, permeable cap consisting of 18 inches of locally available dredge sand overlain with 6 inches of topsoil and vegetation.
- Scenario #5: 24-inch, impermeable cap consisting of a geosynthetic liner (i.e., bentonite mat) overlain with a drainage net, 18 inches of dredge sand, 6 inches of topsoil, and vegetation. This scenario was modeled to allow comparison with the other permeable cap scenarios.

This report presents the findings of the model simulations for each of the above scenarios. Section 2 provides a discussion on the derivation of the input parameters, and Section 3 presents the model results. References used to prepare this report are included in Section 4.

2 Input Parameters

The following subsections discuss how the HELP model input parameters were derived.

2.1 Climate Data

Default characteristics for Portland, Oregon, provided by the HELP program were used for climatological parameter input. Each of the model input climate parameters are discussed below.

2.1.1 Precipitation and Temperature Data Input

The HELP program contains historical precipitation data for several U.S. cities, including Portland, Oregon. The HELP program synthetic weather generator was used to stochastically develop daily precipitation data for the site. Portland was selected as the default city, from which the HELP program generated data having approximately the same statistical characteristics (e.g., rainfall duration and frequency) as that found in the historical database. This precipitation data synthetically generated by the program was used for all model simulations. Similarly, daily temperature data was synthetically generated by the HELP program, using Portland as the default city.

2.1.2 Solar Radiation Input

Solar radiation data was stochastically generated by the HELP program. Portland was used as the default station for historic data with latitude of 45.538.

2.1.3 Evapotranspiration Parameters

Input parameters used by the model to estimate evapotranspiration quantities are discussed in the subsections below.

2.1.3.1 Evaporative Zone Depth

The evaporative zone depth is the maximum depth from which water may be removed by evapotranspiration. Where surface vegetation is present, Shroeder et al (1994a) indicates that the evaporative zone depth should at least equal the expected average depth of root penetration (note, the influence of plant roots usually extends somewhat below the depth of root penetration because of capillary suction of the roots).

Shroeder et al (1994a) states that for bare ground, an evaporative depth should be specified to account for direct evaporation from the soil. In sands, the depths range from approximately 4 to 8 inches, in silts about 8 to 18 inches, and in clays about 12 to 60 inches (Shroeder et al 1994a). As such, for the baseline simulation (Scenario #1) which models the existing soils (poorly graded sands; see Section 2.2.3) without vegetation, an evaporative zone depth of 6 inches was input.

For all other vegetative cap scenarios, an evaporative zone depth of 20 inches was input. This value was provided by the HELP program, based on a layer of loamy soil (i.e., topsoil) with a grassy form of vegetation. For the Portland area, the HELP program recommends using 20 inches for a fair stand of grass and 36 inches for an excellent stand of grass. As such, an evaporative zone depth of 28 inches was input for Scenarios #2 through #5.

2.1.3.2 Maximum Leaf Area Index

Leaf area index (LAI) is defined as the dimensionless ratio of the leaf area of the actively transpiring vegetation to the nominal surface area on which the vegetation is growing. The maximum LAI for bare ground is zero. For a poor stand of grass/vegetation, the LAI approaches 1.0; for a fair stand of grass/vegetation, 2.0; for a good stand of grass/vegetation, 3.5; and for an excellent stand of grass/vegetation, 5.0. For the baseline scenario (no cap with no vegetation), an LAI of zero was input. For the remaining scenarios, an LAI value of 3.5 was used; assuming a good stand of vegetation will exist.

2.1.3.3 Dates Starting and Ending the Growing Season

Shroeder et al (1994a) indicates that the typical growing season starts when the normal mean temperature rises above 50 to 55 degrees Fahrenheit and ends when the mean temperature falls below 50 to 55 degrees. For given cities, the program contains default values for the Julian dates starting and ending the growing season. For Portland, the default Julian start and end dates are 117 (April 27) and 293 (October 19), respectively . These values were used for all scenarios.

2.1.3.4 Normal Average Annual Wind Speed

The normal average annual wind speed input into for all scenarios was 7.9 miles per hour (mph). This value is the default value provided by the HELP program for Portland.

2.1.3.5 Normal Average Quarterly Relative Humidity

The default values for Portland provided by the HELP program were also used for the normal average quarterly relative humidity at the site. The default values used for all scenarios are as follows: 78% for the first quarter; 69% for the second quarter; 67% for the third quarter; and 82% for the fourth quarter.

2.2 Soil and Design Data

The following subsections describe soil and design data for model input.

2.2.1 Cap Area and Percent Runoff

A cap area of 1 acre was simulated for each of the scenarios. It should be noted that runoff, evapotranspiration, and leakage can be readily obtained by multiplying the rates for the 1 acre by the total site acreage. As stated in the beginning of this report, the HELP model is a quasi-two-dimensional model. It simulates one-dimensional (vertical) flow in the vertical percolation layers and horizontal flow in the lateral drainage layers (see Section 2.2.2). Therefore, the model results are not affected by the size of the area being modeled as long as representative design conditions are simulated.

Given the site is currently flat, a runoff fraction of a 5% (i.e., runoff possible over 5% of the area) was input for Scenario #1. For Scenarios #2 through #5, which would be designed/constructed with a surface slope (2% minimum), a runoff fraction of 0.90 (runoff possible over 90% of the area) was input to account for the possibility of localized depressions or other surface features which may reduce runoff.

2.2.2 Layer Types, Thicknesses, and Characteristics

Four layer types are permitted by the HELP program: 1) vertical percolation; 2) lateral drainage; 3) barrier soil liner; and 4) geomembrane liner. Flow in a vertical percolation layer (Layer Type 1) is by unsaturated vertical drainage downward due to gravity drainage and upward flux due to evapotranspiration is modeled as an extraction. The main role of a vertical percolation layer is to provide moisture storage. Lateral drainage layers (Layer Type 2) are layers directly above liners that are designed to promote drainage laterally to a collection and removal system. A lateral drainage layer may only be underlain by another lateral drainage layer or a liner. Barrier soil liners (Layer Type 3) are intended to restrict vertical drainage. These layers should have hydraulic conductivities substantially lower than those of the other types of layers. Liners are assumed to be saturated at all times but leak only when there is a positive head on the top surface of the liner. Evapotranspiration and lateral drainage are not permitted through a liner. Lastly, geomembrane liners (Layer Type 4) are virtually impermeable synthetic membranes that reduce the area of leakage to a very small fraction of the area located near manufacturing flaws or installation defects (e.g., punctures, tears, and faulty seaming).

The HELP program provides 42 default soil and material textures from which the program assigns porosity, field capacity, wilting point, and saturated hydraulic conductivity values. Porosity is defined as the soil water storage divided by the volumetric content at saturation (fraction total volume). Field capacity is the soil water storage divided by the volumetric content after a prolonged period of gravity drainage from saturation corresponding to the soil water storage when a soil exerts a soil suction of 1/3 bar. Wilting point is the lowest soil water storage divided by the volumetric content that can be achieved by plant transpiration or air-drying (i.e., the moisture content where a plant will be permanently wilted) corresponding to the soil water storage when a soil exerts a soil suction of 15 bars. Lastly, saturated hydraulic conductivity is the rate at which water drains through a saturated soil under a unit pressure gradient.

In the HELP program, soils textures are classified according to two standard systems: the U.S. Department of Agriculture (USDA) textural classification system and the Unified Soil Classification System (USCS). A copy of the HELP model default values (for porosity, field capacity, wilting point, and saturated hydraulic conductivity) for each soil and material texture is included in Attachment D1.

Layer types, thicknesses, and associated characteristics for each of the five scenarios are described below.

Scenario #1: For this baseline scenario, only one layer comprised of existing site soils was modeled. This layer is considered a vertical percolation layer (Layer Type 1). A layer thickness of 20 feet (240 inches) was input, which is the approximate depth of the existing site soils above the groundwater table. The site soils are generally considered to be USCS classification SP (poorly graded sands and gravels). As such, the existing 20-foot layer in the baseline Scenario #1 as well as in the remaining scenarios was assigned a HELP Material Texture Number 1 with an associated total porosity of 0.417 vol/vol, field capacity of 0.045 vol/vol, wilting point of 0.018 vol/vol, and a saturated hydraulic conductivity of 1.0×10^{-2} cm/sec.

Scenario #2: For Scenario #2, three layers were modeled, comprised of 20 feet of existing site soils (see Scenario #1, above) overlain with 18 inches of compacted clayey silt and 6 inches of loosely placed clayey silt as topsoil, resulting in a total cap thickness of 24 inches. All layers are considered vertical percolation layers (Layer Type 1). It is assumed the clayey silt will be obtained locally from the Alsop-Brownwood Flood Mitigation and Stream Restoration (Alsop) Project. As presented in a Technical Memorandum for the Alsop project (FHA 2001), the majority of the soils at this site are clayey silts, or USCS classification ML. As such, the bottom 18 inches of the cap was assigned a HELP Material Texture Number 22 (compacted ML; see Attachment D1), with an associated total porosity of 0.419 vol/vol, field capacity of 0.307 vol/vol, wilting point of 0.180 vol/vol, and a saturated hydraulic conductivity of 1.9×10^{-5} cm/sec. The top 6 inches was assigned a HELP Material Texture Number 8 (less consolidated ML), with an associated total porosity of 0.463 vol/vol, field capacity of 0.232 vol/vol, wilting point of 0.116 vol/vol, and a saturated hydraulic conductivity of 3.7×10^{-4} cm/sec (note, when a default soil type is used to describe the top layer, the program adjusts the hydraulic conductivities of the soils in the top half of the evaporative zone for the effects of root channels).

Scenario #3: For this scenario, three layers were modeled, comprised of 20 feet of existing site soils overlain with 18 inches of locally available sandy loam, then 6 inches of loosely placed clayey silt topsoil (from Alsop) for a total cap thickness of 24 inches. All layers were modeled as vertical percolation layers (Layer Type 1). The 20 feet of existing soils and the 6 inches of topsoil are as described in Scenarios #1 and #2, respectively. Sandy loam is classified under USDA as SL. Therefore, per Attachment D1, the 18-inch sandy loam was assigned a HELP Material Texture Number 6 (USDA SL), with an associated total porosity of 0.453 vol/vol, field capacity of 0.190 vol/vol, wilting point of 0.180 vol/vol, and a saturated hydraulic conductivity of 1.9×10^{-5} cm/sec.

Scenario #4: For Scenario #4, three layers were modeled, comprised of 20 feet of existing site soils overlain with 18 inches of locally available dredge sand, then 6 inches of loosely placed clayey silt topsoil, resulting in a total cap thickness of 24 inches. All layers were modeled as vertical percolation layers (Layer Type 1). The 20 feet of existing soils and the 6 inches of topsoil are as described in Scenarios #1 and #2, respectively. Locally available dredge sand is generally classified as USCS soil type SP. Per Attachment D1, the 18-inch dredge sand layer was assigned a HELP Material Texture Number 1, with an associated total porosity of 0.417 vol/vol, field capacity of 0.045 vol/vol, wilting point of 0.018 vol/vol, and a saturated hydraulic conductivity of 1.0×10^{-2} cm/sec.

Scenario #5: For this scenario, an impermeable cap was simulated. Five layers were modeled, comprised of 20 feet of existing site soils overlain with a bentonite mat (e.g., geosynthetic clay liner or GCL), a drainage net (geosynthetic), 18 inches of dredge sand, then 6 inches of topsoil. The 20 feet of existing soils, 6 inches of topsoil, and 18 inches of dredge sand are as described in Scenarios #1, #2, and #4, respectively, and were modeled as vertical percolation layers (Layer Type 1). The bentonite mat was modeled as a barrier soil liner (Layer Type 3) and the drainage net as a lateral drainage layer (Layer Type 2). Per Attachment D1, the bentonite mat was assigned a HELP Material Texture Number 17, with an associated total porosity of 0.750 vol/vol, field capacity of 0.747 vol/vol, wilting point of 0.400 vol/vol, and a saturated hydraulic conductivity of 3.0×10^{-9} cm/sec. Similarly, the drainage net was assigned a HELP Material Texture Number 20, with an associated total porosity of 0.850 vol/vol, field capacity of 0.010 vol/vol, wilting point of 0.005 vol/vol, and a saturated hydraulic conductivity of $1.0\times10^{+1}$ cm/sec.

2.2.3 Runoff Curve Number

The Soil Conservation Service (SCS) runoff curve number (CN) was calculated by the HELP program based on surface slope, slope length, soil texture of the top layer, and vegetation.

Given the site is currently relatively flat, a surface slope of 0.05% for Scenario #1 was input. For Scenarios #2 through #5, a surface slope of 2% (design slope) was used. A slope length of 210 feet (the maximum distance of a square acre) was input for all cap scenarios.

For soil texture, the same HELP Material Texture Numbers for the top layers as described in Section 2.2.2 were used (i.e., HELP Material Texture Number 1 for Scenario #1 and Number 8 for Scenarios #2 through #5).

Lastly, for vegetation, bare ground conditions were input for the baseline Scenario #1 (no cap), and good vegetation conditions were used for Scenarios #2 through #5 (vegetated cap).

The resulting CNs calculated by the program are as follows: 70.4 for Scenario #1 and 72.9 for Scenarios #2 through #5.

2.2.4 Initial Moisture Content

The HELP program was used to estimate the initial moisture content within each layer. The program assumes near steady-state values and then runs the first year of the simulation to improve the initialization to steady-state. The soil water contents at the end of this year of initialization are then taken as the initial values for the simulation period.

3 Model Results

Each of the five cap scenarios was simulated for a period of 5 years. HELP model output, including monthly and yearly results, for Scenario #1 (baseline), Scenario #2, Scenario #3, Scenario #4, and Scenario #5 are included in Attachments D2, D3, D4, D5, and D6, respectively.

The following tables summarize the average annual totals and the daily peak values for the 5-year model simulation period (note, the volumes shown are per acre):

Table 1 – Average Annual Totals for Years 1 through 5

Cap Description	Precipitation			Runoff			Evapotranspiration			Percolation/ Leakage		
	in.	$ft.^3$ (per acre)	%	in.	$ft.^3$ (per acre)	%	in.	$ft.^3$ (per acre)	%	in.	$ft.^3$ (per acre)	%
Scenario #1 (baseline; no cap)	40.05	145,382	100	0.002	7.15	0.005	13.17	47,806	32.9	26.57	96,462	66.4
Scenario #2 (24" clayey silt Alsop soils, compacted)	40.05	145,382	100	0.125	452.36	0.311	17.46	63,375	43.6	21.34	77,480	53.3
Scenario #3 (18" sandy loam, 6" topsoil)	40.05	145,382	100	0.062	223.96	0.154	17.29	62,778	43.1	21.49	78,011	53.7
Scenario #4 (18" dredge sand, 6" topsoil)	40.05	145,382	100	0.034	124.84	0.086	16.11	58,510	40.2	22.81	82,801	57.0
Scenario #5 (impermeable cap with geosynthetics)	40.05	145,382	100	0.043	156.11	0.107	15.98	57,988	39.9	0.062	226.17	0.16

Table 2 – Daily Peak Values for Years 1 through 5

Cap Description	Precipitation		Runoff		Percolation/ Leakage	
	in.	$ft.^3$ (per acre)	in.	$ft.^3$ (per acre)	in.	$ft.^3$ (per acre)
Scenario #1	2.27	8,240	0.008	29.19	0.587	2,133
Scenario #2	2.27	8,240	0.220	798.3	0.342	1,242
Scenario #3	2.27	8,240	0.142	514.3	0.352	1,277
Scenario #4	2.27	8,240	0.097	352.1	0.421	1,529
Scenario #5	2.27	8,240	0.123	448.0	0.002	5.63

As shown in Table 1, the HELP model predicts that for the baseline scenario #1, approximately 66 percent of the 100 percent total precipitation will percolate/leak into the underlying groundwater table, 33 percent will be lost through evapotranspiration, and 0.005 percent will runoff. An increase in water storage is predicted for the remaining 0.995 percent. For the permeable vegetated cap simulations (Scenarios #2 through #4), the program predicts a decrease in percolation of approximately 13 percent for Scenarios #2 and #3; and a decrease of approximately 9 percent for scenario #4. These leakage reductions are mainly due to an increase in evapotranspiration (runoff quantities remained relatively unchanged). A more significant decrease in percolation is predicted for Scenario #5, where placement of a geosynthetic liner (and drainage layer) results in a percolation of 0.16 percent.

3 References

Fujitani Hilts & Associates, Inc. (FHA), October 2001, *Technical Memorandum – Geotechnical Investigation for Alsop-Brownwood Flood Mitigation and Stream Restoration Project*, Portland, OR.

Schroeder et al, 1994a, *The Hydrologic Evaluation of Landfill Performance (HELP) Model: User's Guide for Version 3"*, Environmental Laboratory, U.S.A.E. Waterways Experiment Station, Vicksburg, MS, for U.S. Environmental Protection Agency, Risk Reduction Engineering Laboratory, Office of Research and Development, Cincinnati, OH.

______, 1994b, *The Hydrologic Evaluation of Landfill Performance (HELP) Model: Engineering Documentation for Version 3"*, Environmental Laboratory, U.S.A.E. Waterways Experiment Station, Vicksburg, MS, for U.S. Environmental Protection Agency, Risk Reduction Engineering Laboratory, Office of Research and Development, Cincinnati, OH.

Tetra Tech EM Inc., 2002, *Final Engineering Evaluation and Cost Analysis Golden Belt, Golden Turkey, and French Lily Mines*, Albuquerque, NM, submitted to Prescott National Forest U.S.D.A. Forest Service, Southwest Region.

United States Environmental Protection Agency and the State of Oregon Department of Environmental Quality (EPA/DEQ), 1996, *Record of Decision*, prepared for McCormick & Baxter Creosoting Company, Portland, Oregon.

ATTACHMENT D1

SOIL/MATERIAL CLASSIFICATION AND CHARACTERISTICS

THE HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE (HELP) MODEL

USER'S GUIDE FOR VERSION 3

by

Paul R. Schroeder, Cheryl M. Lloyd, and Paul A. Zappi
Environmental Laboratory
U.S. Army Corps of Engineers
Waterways Experiment Station
Vicksburg, Mississippi 39180-6199

and

Nadim M. Aziz
Department of Civil Engineering
Clemson University
Clemson, South Carolina 29634-0911

Interagency Agreement No. DW21931425

Project Officer

Robert E. Landreth
Waste Minimization, Destruction and Disposal Research Division
Risk Reduction Engineering Laboratory
Cincinnati, Ohio 45268

RISK REDUCTION ENGINEERING LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO 45268

TABLE 4. DEFAULT SOIL, WASTE, AND GEOSYNTHETIC CHARACTERISTICS

Classification			Total Porosity	Field Capacity	Wilting Point	Saturated Hydraulic Conductivity
HELP	USDA	USCS	vol/vol	vol/vol	vol/vol	cm/sec
1	CoS	SP	0.417	0.045	0.018	1.0×10^{-2}
2	S	SW	0.437	0.062	0.024	5.8×10^{-3}
3	FS	SW	0.457	0.083	0.033	3.1×10^{-3}
4	LS	SM	0.437	0.105	0.047	1.7×10^{-3}
5	LFS	SM	0.457	0.131	0.058	1.0×10^{-3}
6	SL	SM	0.453	0.190	0.085	7.2×10^{-4}
7	FSL	SM	0.473	0.222	0.104	5.2×10^{-4}
8	L	ML	0.463	0.232	0.116	3.7×10^{-4}
9	SiL	ML	0.501	0.284	0.135	1.9×10^{-4}
10	SCL	SC	0.398	0.244	0.136	1.2×10^{-4}
11	CL	CL	0.464	0.310	0.187	6.4×10^{-5}
12	SiCL	CL	0.471	0.342	0.210	4.2×10^{-5}
13	SC	SC	0.430	0.321	0.221	3.3×10^{-5}
14	SiC	CH	0.479	0.371	0.251	2.5×10^{-5}
15	C	CH	0.475	0.378	0.265	1.7×10^{-5}
16	Barrier Soil		0.427	0.418	0.367	1.0×10^{-7}
17	Bentonite Mat (0.6 cm)		0.750	0.747	0.400	3.0×10^{-9}
18	Municipal Waste (900 lb/yd³ or 312 kg/m³)		0.671	0.292	0.077	1.0×10^{-3}
19	Municipal Waste (channeling and dead zones)		0.168	0.073	0.019	1.0×10^{-3}
20	Drainage Net (0.5 cm)		0.850	0.010	0.005	$1.0 \times 10^{+1}$
21	Gravel		0.397	0.032	0.013	3.0×10^{-1}
22	L*	ML	0.419	0.307	0.180	1.9×10^{-5}
23	SiL*	ML	0.461	0.360	0.203	9.0×10^{-6}
24	SCL*	SC	0.365	0.305	0.202	2.7×10^{-6}
25	CL*	CL	0.437	0.373	0.266	3.6×10^{-6}
26	SiCL*	CL	0.445	0.393	0.277	1.9×10^{-6}
27	SC*	SC	0.400	0.366	0.288	7.8×10^{-7}
28	SiC*	CH	0.452	0.411	0.311	1.2×10^{-6}
29	C*	CH	0.451	0.419	0.332	6.8×10^{-7}
30	Coal-Burning Electric Plant Fly Ash*		0.541	0.187	0.047	5.0×10^{-5}
31	Coal-Burning Electric Plant Bottom Ash*		0.578	0.076	0.025	4.1×10^{-3}
32	Municipal Incinerator Fly Ash*		0.450	0.116	0.049	1.0×10^{-2}
33	Fine Copper Slag*		0.375	0.055	0.020	4.1×10^{-2}
34	Drainage Net (0.6 cm)		0.850	0.010	0.005	$3.3 \times 10^{+1}$

* Moderately Compacted

(Continued)

TABLE 4 (continued). DEFAULT SOIL, WASTE, AND GEOSYNTHETIC CHARACTERISTICS

Classification		Total Porosity	Field Capacity	Wilting Point	Saturated Hydraulic Conductivity
HELP	Geomembrane Material	vol/vol	vol/vol	vol/vol	cm/sec
35	High Density Polyethylene (HDPE)				2.0×10^{-13}
36	Low Density Polyethylene (LDPE)				4.0×10^{-13}
37	Polyvinyl Chloride (PVC)				2.0×10^{-11}
38	Butyl Rubber				1.0×10^{-12}
39	Chlorinated Polyethylene (CPE)				4.0×10^{-12}
40	Hypalon or Chlorosulfonated Polyethylene (CSPE)				3.0×10^{-12}
41	Ethylene-Propylene Diene Monomer (EPDM)				2.0×10^{-12}
42	Neoprene				3.0×10^{-12}

(concluded)

ATTACHMENT D2

MODEL OUTPUT FOR SCENARIO #1

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07   (1 NOVEMBER 1997)               **
**                 DEVELOPED BY ENVIRONMENTAL LABORATORY                    **
**                   USAE WATERWAYS EXPERIMENT STATION                      **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:      C:\HELP3\M&B\WEATHER\BASELINE.D4
TEMPERATURE DATA FILE:        C:\HELP3\M&B\WEATHER\BASELINE.D7
SOLAR RADIATION DATA FILE:    C:\HELP3\M&B\WEATHER\BASELINE.D13
EVAPOTRANSPIRATION DATA:      C:\HELP3\M&B\WEATHER\BASELINE.D11
SOIL AND DESIGN DATA FILE:    C:\HELP3\M&B\DESIGN\S1.D10
OUTPUT DATA FILE:             C:\HELP3\M&B\OUTPUT\S1.OUT


TIME:  11:48       DATE:   1/29/2004


******************************************************************************

    TITLE:  McCormick & Baxter Upland Cap:  Scenario #1 (baseline)

******************************************************************************


    NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
             COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                       TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER    1
          THICKNESS                  =    240.00   INCHES
          POROSITY                   =      0.4170 VOL/VOL
          FIELD CAPACITY             =      0.0450 VOL/VOL
          WILTING POINT              =      0.0180 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.1355 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.999999978000E-02 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	70.40	
FRACTION OF AREA ALLOWING RUNOFF	=	5.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	6.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	0.925	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	2.502	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.108	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	32.516	INCHES
TOTAL INITIAL WATER	=	32.516	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
PORTLAND OREGON

STATION LATITUDE	=	45.53	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	117	
END OF GROWING SEASON (JULIAN DATE)	=	293	
EVAPORATIVE ZONE DEPTH	=	6.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	7.90	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	78.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	69.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	82.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR PORTLAND OREGON

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
6.16	3.93	3.61	2.31	2.08	1.47
0.46	1.13	1.61	3.05	5.17	6.41

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR PORTLAND OREGON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
38.90	43.20	45.90	50.40	56.70	62.50
67.70	67.30	62.70	54.30	45.50	40.90

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR PORTLAND OREGON
AND STATION LATITUDE = 45.53 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	5.05	2.82	1.81	2.03	3.75	0.41
	0.79	0.75	1.13	4.46	5.39	7.39
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.917	1.326	1.850	1.193	2.420	0.923
	0.455	0.798	0.403	1.729	0.992	0.723
PERCOLATION/LEAKAGE THROUGH LAYER 1	3.6541	3.5672	2.6713	1.3711	1.3685	0.8299
	1.0494	0.7299	0.4587	0.3909	0.7846	3.3155

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	35.78	129881.437	100.00
RUNOFF	0.000	1.223	0.00
EVAPOTRANSPIRATION	13.728	49833.633	38.37
PERC./LEAKAGE THROUGH LAYER 1	20.191074	73293.602	56.43
CHANGE IN WATER STORAGE	1.860	6752.965	5.20

SOIL WATER AT START OF YEAR	32.516	118033.883	
SOIL WATER AT END OF YEAR	34.377	124786.844	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.014	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 2

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	8.76	5.48	5.48	3.29	1.43	0.55
	0.08	2.72	1.18	1.96	6.46	7.56
RUNOFF	0.001	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.583	1.138	1.997	2.578	0.970	0.572
	0.194	1.679	0.597	0.930	0.832	0.519
PERCOLATION/LEAKAGE THROUGH	6.5007	5.9756	4.9407	3.4098	2.5433	1.5200
LAYER 1	1.1507	0.6013	0.6988	0.5608	0.4614	2.5728

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	44.95	163168.484	100.00
RUNOFF	0.001	2.653	0.00
EVAPOTRANSPIRATION	12.590	45701.133	28.01
PERC./LEAKAGE THROUGH LAYER 1	30.936022	112297.758	68.82
CHANGE IN WATER STORAGE	1.423	5166.987	3.17

SOIL WATER AT START OF YEAR	34.377	124786.844	
SOIL WATER AT END OF YEAR	35.800	129953.828	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.042	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 3

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	4.92	6.48	4.18	2.33	2.09	2.06
	0.39	1.06	1.48	3.65	7.37	10.26
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.941	1.282	1.990	1.649	1.017	1.885
	0.287	0.956	0.453	1.731	0.895	0.535
PERCOLATION/LEAKAGE THROUGH LAYER 1	5.9490	4.5756	4.5996	2.9776	1.8180	1.7905
	1.3257	0.9258	0.6916	0.4278	1.1368	4.8166

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	46.27	167960.109	100.00
RUNOFF	0.000	1.162	0.00
EVAPOTRANSPIRATION	13.621	49443.598	29.44
PERC./LEAKAGE THROUGH LAYER 1	31.034586	112655.547	67.07
CHANGE IN WATER STORAGE	1.614	5859.802	3.49

SOIL WATER AT START OF YEAR	35.800	129953.828	
SOIL WATER AT END OF YEAR	36.150	131222.812	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	1.265	4590.816	2.73
ANNUAL WATER BUDGET BALANCE	0.0000	0.007	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 4

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	6.81	3.49	3.28	2.65	1.57	0.65
	0.25	0.91	1.83	3.91	5.34	3.80
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.686	1.272	1.926	2.063	1.418	0.312
	0.259	0.803	1.130	1.170	0.901	0.658
PERCOLATION/LEAKAGE THROUGH LAYER 1	6.9460	5.9798	3.5167	2.0097	2.1193	1.3264
	0.9433	0.7602	0.4465	0.2443	0.6228	2.4206

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.49	125198.703	100.00
RUNOFF	0.000	1.493	0.00
EVAPOTRANSPIRATION	12.599	45732.930	36.53
PERC./LEAKAGE THROUGH LAYER 1	27.335470	99227.758	79.26
CHANGE IN WATER STORAGE	-5.444	-19763.504	-15.79

SOIL WATER AT START OF YEAR	36.150	131222.812	
SOIL WATER AT END OF YEAR	31.970	116050.125	
SNOW WATER AT START OF YEAR	1.265	4590.816	3.67
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.028	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	3.80	5.91	3.99	1.37	2.44	1.30
	0.27	0.00	2.76	3.08	6.13	7.71
RUNOFF	0.000	0.008	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.815	1.200	2.113	1.391	1.847	1.379
	0.213	0.039	0.826	1.730	0.970	0.788
PERCOLATION/LEAKAGE THROUGH LAYER 1	3.5469	2.5130	3.9863	3.1380	1.6580	1.2610
	0.9305	0.7595	0.6292	0.2375	0.8044	3.9060

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	38.76	140698.781	100.00
RUNOFF	0.008	29.194	0.02
EVAPOTRANSPIRATION	13.311	48318.203	34.34
PERC./LEAKAGE THROUGH LAYER 1	23.370066	84833.336	60.29
CHANGE IN WATER STORAGE	2.071	7518.066	5.34

SOIL WATER AT START OF YEAR	31.970	116050.125	
SOIL WATER AT END OF YEAR	34.041	123568.195	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.021	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	5.87	4.84	3.75	2.33	2.26	0.99
	0.36	1.09	1.68	3.41	6.14	7.34
STD. DEVIATIONS	1.94	1.59	1.34	0.71	0.93	0.69
	0.27	1.00	0.67	0.95	0.84	2.30
RUNOFF						
TOTALS	0.000	0.002	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.004	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.788	1.243	1.975	1.775	1.535	1.014
	0.282	0.855	0.682	1.458	0.918	0.645
STD. DEVIATIONS	0.153	0.075	0.097	0.555	0.609	0.630
	0.104	0.583	0.299	0.382	0.064	0.117
PERCOLATION/LEAKAGE THROUGH LAYER 1						
TOTALS	5.3193	4.5222	3.9429	2.5812	1.9014	1.3455
	1.0799	0.7553	0.5850	0.3723	0.7620	3.4063
STD. DEVIATIONS	1.6088	1.5157	0.8983	0.8580	0.4499	0.3542
	0.1638	0.1156	0.1239	0.1356	0.2513	0.9891

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 5

	INCHES		CU. FEET	PERCENT
PRECIPITATION	40.05	(5.327)	145381.5	100.00
RUNOFF	0.002	(0.0034)	7.15	0.005
EVAPOTRANSPIRATION	13.170	(0.5472)	47805.89	32.883
PERCOLATION/LEAKAGE THROUGH LAYER 1	26.57344	(4.75686)	96461.602	66.35067
CHANGE IN WATER STORAGE	0.305	(3.2233)	1106.86	0.761

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	2.27	8240.100
RUNOFF	0.008	29.1936
PERCOLATION/LEAKAGE THROUGH LAYER 1	0.587719	2133.42017
SNOW WATER	1.74	6306.4038
MAXIMUM VEG. SOIL WATER (VOL/VOL)		0.2437
MINIMUM VEG. SOIL WATER (VOL/VOL)		0.0180

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	34.0408	0.1418
SNOW WATER	0.000	

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ATTACHMENT D3

MODEL OUTPUT FOR SCENARIO #2

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**                                                                          **
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**             HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                   **
**              DEVELOPED BY ENVIRONMENTAL LABORATORY                       **
**                USAE WATERWAYS EXPERIMENT STATION                         **
**        FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                   **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:      C:\HELP3\M&B\WEATHER\VEG.D4
TEMPERATURE DATA FILE:        C:\HELP3\M&B\WEATHER\VEG.D7
SOLAR RADIATION DATA FILE:    C:\HELP3\M&B\WEATHER\VEG.D13
EVAPOTRANSPIRATION DATA:      C:\HELP3\M&B\WEATHER\VEG.D11
SOIL AND DESIGN DATA FILE:    C:\HELP3\M&B\DESIGN\S2.D10
OUTPUT DATA FILE:             C:\HELP3\M&B\OUTPUT\S2.OUT


TIME:  12:12     DATE:   1/29/2004


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    TITLE:  McCormick & Baxter Upland Cap:   Scenario #2

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    NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
             COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                 LAYER  1
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                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   8
        THICKNESS                     =      6.00    INCHES
        POROSITY                      =      0.4630 VOL/VOL
        FIELD CAPACITY                =      0.2320 VOL/VOL
        WILTING POINT                 =      0.1160 VOL/VOL
        INITIAL SOIL WATER CONTENT    =      0.3005 VOL/VOL
        EFFECTIVE SAT. HYD. COND.     =  0.369999994000E-03 CM/SEC
      NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
             FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
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LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 22

THICKNESS	=	18.00 INCHES
POROSITY	=	0.4190 VOL/VOL
FIELD CAPACITY	=	0.3070 VOL/VOL
WILTING POINT	=	0.1800 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3509 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.189999992000E-04 CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1

THICKNESS	=	240.00 INCHES
POROSITY	=	0.4170 VOL/VOL
FIELD CAPACITY	=	0.0450 VOL/VOL
WILTING POINT	=	0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1136 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999978000E-02 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 8 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 2.% AND A SLOPE LENGTH OF 210. FEET.

SCS RUNOFF CURVE NUMBER	=	72.90	
FRACTION OF AREA ALLOWING RUNOFF	=	90.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	28.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	8.725	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	11.988	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	4.008	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	35.387	INCHES
TOTAL INITIAL WATER	=	35.387	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM PORTLAND OREGON

STATION LATITUDE	=	45.53 DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50
START OF GROWING SEASON (JULIAN DATE)	=	117
END OF GROWING SEASON (JULIAN DATE)	=	293
EVAPORATIVE ZONE DEPTH	=	28.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	7.90 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	78.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	69.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	67.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	82.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR PORTLAND OREGON

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
6.16	3.93	3.61	2.31	2.08	1.47
0.46	1.13	1.61	3.05	5.17	6.41

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR PORTLAND OREGON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
38.90	43.20	45.90	50.40	56.70	62.50
67.70	67.30	62.70	54.30	45.50	40.90

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR PORTLAND OREGON AND STATION LATITUDE = 45.53 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	5.05 0.79	2.82 0.75	1.81 1.13	2.03 4.46	3.75 5.39	0.41 7.39
RUNOFF	0.034 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.032
EVAPOTRANSPIRATION	0.820 0.789	1.217 0.751	2.143 1.130	3.001 1.409	2.670 0.889	3.018 0.649
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.0059 0.7763	2.4499 0.6364	2.5092 0.5153	1.9063 0.4546	1.3363 0.3848	0.9478 0.2589

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	35.78	129881.437	100.00
RUNOFF	0.067	241.769	0.19
EVAPOTRANSPIRATION	18.485	67099.383	51.66
PERC./LEAKAGE THROUGH LAYER 3	12.181714	44219.621	34.05
CHANGE IN WATER STORAGE	5.047	18320.613	14.11
SOIL WATER AT START OF YEAR	35.387	128454.344	
SOIL WATER AT END OF YEAR	40.434	146774.953	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.052	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 2

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	8.76 0.08	5.48 2.72	5.48 1.18	3.29 1.96	1.43 6.46	0.55 7.56
RUNOFF	0.152 0.000	0.011 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.027
EVAPOTRANSPIRATION	0.558 0.080	1.079 2.720	1.985 1.159	3.899 1.080	1.975 0.739	1.966 0.487
PERCOLATION/LEAKAGE THROUGH LAYER 3	4.5891 1.1909	5.8848 0.8853	5.1101 0.6739	3.4506 0.5697	2.4229 0.4729	1.6409 0.2118

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	44.95	163168.484	100.00
RUNOFF	0.190	690.676	0.42
EVAPOTRANSPIRATION	17.726	64343.875	39.43
PERC./LEAKAGE THROUGH LAYER 3	27.102949	98383.703	60.30
CHANGE IN WATER STORAGE	-0.069	-249.779	-0.15
SOIL WATER AT START OF YEAR	40.434	146774.953	
SOIL WATER AT END OF YEAR	40.365	146525.172	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.007	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 3

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	4.92 0.39	6.48 1.06	4.18 1.48	2.33 3.65	2.09 7.37	2.06 10.26
RUNOFF	0.000 0.000	0.031 0.000	0.000 0.000	0.000 0.000	0.000 0.045	0.000 0.034
EVAPOTRANSPIRATION	0.877 0.390	1.182 1.059	1.915 0.722	3.014 1.541	3.232 0.724	3.157 0.508
PERCOLATION/LEAKAGE THROUGH LAYER 3	2.5411 1.0918	4.5608 0.8223	4.7661 0.6331	2.7949 0.5398	2.5389 0.3500	1.4993 1.3962

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	46.27	167960.109	100.00
RUNOFF	0.109	397.399	0.24
EVAPOTRANSPIRATION	18.320	66501.875	39.59
PERC./LEAKAGE THROUGH LAYER 3	23.534332	85429.625	50.86
CHANGE IN WATER STORAGE	4.306	15631.170	9.31
SOIL WATER AT START OF YEAR	40.365	146525.172	
SOIL WATER AT END OF YEAR	43.406	157565.531	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	1.265	4590.816	2.73
ANNUAL WATER BUDGET BALANCE	0.0000	0.042	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 4

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	6.81	3.49	3.28	2.65	1.57	0.65
	0.25	0.91	1.83	3.91	5.34	3.80
RUNOFF	0.030	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.652	1.172	1.937	3.440	2.691	1.263
	0.183	0.976	1.148	1.411	0.818	0.568
PERCOLATION/LEAKAGE THROUGH LAYER 3	6.0035	5.9894	3.8469	1.8558	2.3680	1.5045
	1.1054	0.8307	0.6386	0.5438	0.4471	0.2534

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.49	125198.703	100.00
RUNOFF	0.031	111.209	0.09
EVAPOTRANSPIRATION	16.259	59019.922	47.14
PERC./LEAKAGE THROUGH LAYER 3	25.386967	92154.687	73.61
CHANGE IN WATER STORAGE	-7.187	-26087.139	-20.84
SOIL WATER AT START OF YEAR	43.406	157565.531	
SOIL WATER AT END OF YEAR	37.485	136069.203	
SNOW WATER AT START OF YEAR	1.265	4590.816	3.67
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.028	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	3.80 0.27	5.91 0.00	3.99 2.76	1.37 3.08	2.44 6.13	1.30 7.71
RUNOFF	0.000 0.000	0.220 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.006
EVAPOTRANSPIRATION	0.744 0.270	1.132 0.000	2.080 1.120	2.348 1.607	3.171 0.870	2.439 0.724
PERCOLATION/LEAKAGE THROUGH LAYER 3	1.5340 1.0091	1.8688 0.7753	4.1539 0.6041	2.9968 0.5192	2.2118 0.3873	1.3552 1.1010

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	38.76	140698.781	100.00
RUNOFF	0.226	820.749	0.58
EVAPOTRANSPIRATION	16.505	59913.320	42.58
PERC./LEAKAGE THROUGH LAYER 3	18.516466	67214.773	47.77
CHANGE IN WATER STORAGE	3.512	12749.948	9.06
SOIL WATER AT START OF YEAR	37.485	136069.203	
SOIL WATER AT END OF YEAR	40.997	148819.156	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.007	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	5.87	4.84	3.75	2.33	2.26	0.99
	0.36	1.09	1.68	3.41	6.14	7.34
STD. DEVIATIONS	1.94	1.59	1.34	0.71	0.93	0.69
	0.27	1.00	0.67	0.95	0.84	2.30
RUNOFF						
TOTALS	0.043	0.052	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.009	0.020
STD. DEVIATIONS	0.063	0.095	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.020	0.016
EVAPOTRANSPIRATION						
TOTALS	0.730	1.156	2.012	3.140	2.748	2.369
	0.342	1.101	1.056	1.409	0.808	0.587
STD. DEVIATIONS	0.128	0.053	0.097	0.576	0.505	0.780
	0.274	0.997	0.187	0.203	0.075	0.099
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	2.9347	4.1507	4.0772	2.6009	2.1756	1.3895
	1.0347	0.7900	0.6130	0.5254	0.4084	0.6443
STD. DEVIATIONS	2.3900	1.9141	1.0074	0.6989	0.4837	0.2668
	0.1582	0.0943	0.0600	0.0435	0.0502	0.5618

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 5

	INCHES		CU. FEET	PERCENT
PRECIPITATION	40.05	(5.327)	145381.5	100.00
RUNOFF	0.125	(0.0822)	452.36	0.311
EVAPOTRANSPIRATION	17.459	(1.0265)	63375.68	43.593
PERCOLATION/LEAKAGE THROUGH LAYER 3	21.34449	(6.04672)	77480.484	53.29459
CHANGE IN WATER STORAGE	1.122	(5.0425)	4072.96	2.802

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	2.27	8240.100
RUNOFF	0.220	798.2607
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.342173	1242.08667
SNOW WATER	1.74	6306.4038
MAXIMUM VEG. SOIL WATER (VOL/VOL)		0.3326
MINIMUM VEG. SOIL WATER (VOL/VOL)		0.1431

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	1.5688	0.2615
2	6.3294	0.3516
3	33.0989	0.1379
SNOW WATER	0.000	

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ATTACHMENT D4

MODEL OUTPUT FOR SCENARIO #3

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**                                                                          **
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**               HELP MODEL VERSION 3.07   (1 NOVEMBER 1997)                **
**                DEVELOPED BY ENVIRONMENTAL LABORATORY                     **
**                  USAE WATERWAYS EXPERIMENT STATION                       **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:      C:\HELP3\M&B\WEATHER\VEG.D4
TEMPERATURE DATA FILE:        C:\HELP3\M&B\WEATHER\VEG.D7
SOLAR RADIATION DATA FILE:    C:\HELP3\M&B\WEATHER\VEG.D13
EVAPOTRANSPIRATION DATA:      C:\HELP3\M&B\WEATHER\VEG.D11
SOIL AND DESIGN DATA FILE:    C:\HELP3\M&B\DESIGN\S3.D10
OUTPUT DATA FILE:             C:\HELP3\M&B\OUTPUT\S3.OUT


TIME: 13:48     DATE:   1/29/2004


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    TITLE:  McCormick & Baxter Upland Cap:   Scenario #3

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    NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
             COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                      TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER    8
          THICKNESS                 =         6.00   INCHES
          POROSITY                  =         0.4630 VOL/VOL
          FIELD CAPACITY            =         0.2320 VOL/VOL
          WILTING POINT             =         0.1160 VOL/VOL
          INITIAL SOIL WATER CONTENT =        0.2925 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =   0.369999994000E-03 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
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LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6

THICKNESS	=	18.00 INCHES
POROSITY	=	0.4530 VOL/VOL
FIELD CAPACITY	=	0.1900 VOL/VOL
WILTING POINT	=	0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2663 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.720000011000E-03 CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1

THICKNESS	=	240.00 INCHES
POROSITY	=	0.4170 VOL/VOL
FIELD CAPACITY	=	0.0450 VOL/VOL
WILTING POINT	=	0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1119 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999978000E-02 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 8 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 2.% AND A SLOPE LENGTH OF 210. FEET.

SCS RUNOFF CURVE NUMBER	=	72.90	
FRACTION OF AREA ALLOWING RUNOFF	=	90.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	28.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	7.145	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	12.600	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	2.298	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	33.414	INCHES
TOTAL INITIAL WATER	=	33.414	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
PORTLAND OREGON

STATION LATITUDE	=	45.53 DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50
START OF GROWING SEASON (JULIAN DATE)	=	117
END OF GROWING SEASON (JULIAN DATE)	=	293
EVAPORATIVE ZONE DEPTH	=	28.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	7.90 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	78.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	69.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	67.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	82.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR PORTLAND OREGON

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
6.16	3.93	3.61	2.31	2.08	1.47
0.46	1.13	1.61	3.05	5.17	6.41

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR PORTLAND OREGON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
38.90	43.20	45.90	50.40	56.70	62.50
67.70	67.30	62.70	54.30	45.50	40.90

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR PORTLAND OREGON
AND STATION LATITUDE = 45.53 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	5.05	2.82	1.81	2.03	3.75	0.41
	0.79	0.75	1.13	4.46	5.39	7.39
RUNOFF	0.014	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.018
EVAPOTRANSPIRATION	0.819	1.216	2.142	2.897	2.667	2.946
	0.788	0.752	1.130	1.411	0.887	0.648
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.0028	2.1285	2.4782	1.9136	1.3584	0.9599
	0.8104	0.6713	0.5420	0.4760	0.4031	0.2297

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	35.78	129881.437	100.00
RUNOFF	0.033	118.067	0.09
EVAPOTRANSPIRATION	18.302	66434.750	51.15
PERC./LEAKAGE THROUGH LAYER 3	11.973840	43465.039	33.47
CHANGE IN WATER STORAGE	5.472	19863.555	15.29
SOIL WATER AT START OF YEAR	33.414	121292.953	
SOIL WATER AT END OF YEAR	38.886	141156.500	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.028	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 2

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	8.76 0.08	5.48 2.72	5.48 1.18	3.29 1.96	1.43 6.46	0.55 7.56
RUNOFF	0.076 0.000	0.001 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.005
EVAPOTRANSPIRATION	0.557 0.080	1.077 2.720	1.984 1.157	3.816 1.078	1.912 0.736	1.955 0.486
PERCOLATION/LEAKAGE THROUGH LAYER 3	4.4759 1.2602	6.0194 0.9376	4.9807 0.7087	3.5886 0.5953	2.5054 0.4955	1.6244 0.2004

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	44.95	163168.484	100.00
RUNOFF	0.083	300.279	0.18
EVAPOTRANSPIRATION	17.558	63737.191	39.06
PERC./LEAKAGE THROUGH LAYER 3	27.392040	99433.109	60.94
CHANGE IN WATER STORAGE	-0.083	-302.108	-0.19
SOIL WATER AT START OF YEAR	38.886	141156.500	
SOIL WATER AT END OF YEAR	38.803	140854.391	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.021	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 3

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	4.92	6.48	4.18	2.33	2.09	2.06
	0.39	1.06	1.48	3.65	7.37	10.26
RUNOFF	0.000	0.016	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.023	0.005
EVAPOTRANSPIRATION	0.876	1.179	1.912	2.900	3.179	3.157
	0.391	1.057	0.724	1.553	0.721	0.507
PERCOLATION/LEAKAGE THROUGH LAYER 3	2.5161	4.5318	4.7432	2.8783	2.5487	1.5418
	1.1425	0.8646	0.6630	0.5627	0.3639	1.2863

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	46.27	167960.109	100.00
RUNOFF	0.044	158.538	0.09
EVAPOTRANSPIRATION	18.157	65908.195	39.24
PERC./LEAKAGE THROUGH LAYER 3	23.643152	85824.641	51.10
CHANGE IN WATER STORAGE	4.427	16068.761	9.57
SOIL WATER AT START OF YEAR	38.803	140854.391	
SOIL WATER AT END OF YEAR	41.965	152332.344	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	1.265	4590.816	2.73
ANNUAL WATER BUDGET BALANCE	0.0000	-0.028	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 4

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	6.81 0.25	3.49 0.91	3.28 1.83	2.65 3.91	1.57 5.34	0.65 3.80
RUNOFF	0.007 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000
EVAPOTRANSPIRATION	0.651 0.183	1.170 0.974	1.934 1.167	3.419 1.408	2.709 0.818	1.123 0.568
PERCOLATION/LEAKAGE THROUGH LAYER 3	6.2015 1.1625	5.9526 0.8702	3.7961 0.6650	1.8908 0.5635	2.3755 0.4597	1.5421 0.2049

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.49	125198.703	100.00
RUNOFF	0.007	25.636	0.02
EVAPOTRANSPIRATION	16.126	58537.488	46.76
PERC./LEAKAGE THROUGH LAYER 3	25.684364	93234.242	74.47
CHANGE IN WATER STORAGE	-7.327	-26598.687	-21.25
SOIL WATER AT START OF YEAR	41.965	152332.344	
SOIL WATER AT END OF YEAR	35.902	130324.469	
SNOW WATER AT START OF YEAR	1.265	4590.816	3.67
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.028	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	3.80	5.91	3.99	1.37	2.44	1.30
	0.27	0.00	2.76	3.08	6.13	7.71
RUNOFF	0.000	0.142	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.001
EVAPOTRANSPIRATION	0.744	1.132	2.081	2.201	3.113	2.484
	0.269	0.001	1.120	1.591	0.869	0.723
PERCOLATION/LEAKAGE THROUGH LAYER 3	1.5243	1.8571	4.2754	2.9509	2.2335	1.4008
	1.0578	0.8122	0.6298	0.5388	0.3946	1.0843

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	38.76	140698.781	100.00
RUNOFF	0.143	517.280	0.37
EVAPOTRANSPIRATION	16.329	59272.582	42.13
PERC./LEAKAGE THROUGH LAYER 3	18.759501	68096.984	48.40
CHANGE IN WATER STORAGE	3.529	12811.930	9.11
SOIL WATER AT START OF YEAR	35.902	130324.469	
SOIL WATER AT END OF YEAR	39.432	143136.406	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.000	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	5.87	4.84	3.75	2.33	2.26	0.99
	0.36	1.09	1.68	3.41	6.14	7.34
STD. DEVIATIONS	1.94	1.59	1.34	0.71	0.93	0.69
	0.27	1.00	0.67	0.95	0.84	2.30
RUNOFF						
TOTALS	0.019	0.032	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.005	0.006
STD. DEVIATIONS	0.032	0.062	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.010	0.007
EVAPOTRANSPIRATION						
TOTALS	0.729	1.155	2.011	3.047	2.716	2.333
	0.342	1.101	1.060	1.409	0.806	0.586
STD. DEVIATIONS	0.128	0.053	0.098	0.610	0.505	0.819
	0.274	0.997	0.188	0.202	0.075	0.099
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	2.9442	4.0979	4.0547	2.6444	2.2043	1.4138
	1.0867	0.8312	0.6417	0.5472	0.4234	0.6011
STD. DEVIATIONS	2.4396	2.0137	0.9915	0.7318	0.4886	0.2662
	0.1704	0.0999	0.0624	0.0446	0.0532	0.5382

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 5

	INCHES		CU. FEET	PERCENT
PRECIPITATION	40.05	(5.327)	145381.5	100.00
RUNOFF	0.062	(0.0528)	223.96	0.154
EVAPOTRANSPIRATION	17.294	(1.0156)	62778.04	43.182
PERCOLATION/LEAKAGE THROUGH LAYER 3	21.49058	(6.22647)	78010.805	53.65937
CHANGE IN WATER STORAGE	1.203	(5.2070)	4368.69	3.005

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	2.27	8240.100
RUNOFF	0.142	514.2568
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.351849	1277.21082
SNOW WATER	1.74	6306.4038
MAXIMUM VEG. SOIL WATER (VOL/VOL)		0.2916
MINIMUM VEG. SOIL WATER (VOL/VOL)		0.0821

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	1.5237	0.2539
2	4.8342	0.2686
3	33.0737	0.1378
SNOW WATER	0.000	

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ATTACHMENT D5

MODEL OUTPUT FOR SCENARIO #4

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:      C:\HELP3\M&B\WEATHER\VEG.D4
TEMPERATURE DATA FILE:        C:\HELP3\M&B\WEATHER\VEG.D7
SOLAR RADIATION DATA FILE:    C:\HELP3\M&B\WEATHER\VEG.D13
EVAPOTRANSPIRATION DATA:      C:\HELP3\M&B\WEATHER\VEG.D11
SOIL AND DESIGN DATA FILE:    C:\HELP3\M&B\DESIGN\S4.D10
OUTPUT DATA FILE:             C:\HELP3\M&B\OUTPUT\S4.OUT


TIME:  13:53     DATE:   1/29/2004


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    TITLE:  McCormick & Baxter Upland Cap:  Scenario #4

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    NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
             COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                       TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER   8
         THICKNESS                    =          6.00    INCHES
         POROSITY                     =          0.4630 VOL/VOL
         FIELD CAPACITY               =          0.2320 VOL/VOL
         WILTING POINT                =          0.1160 VOL/VOL
         INITIAL SOIL WATER CONTENT   =          0.2695 VOL/VOL
         EFFECTIVE SAT. HYD. COND.    =  0.369999994000E-03 CM/SEC
       NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
                FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
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LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1

THICKNESS	=	18.00	INCHES
POROSITY	=	0.4170	VOL/VOL
FIELD CAPACITY	=	0.0450	VOL/VOL
WILTING POINT	=	0.0180	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1412	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999978000E-02	CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1

THICKNESS	=	240.00	INCHES
POROSITY	=	0.4170	VOL/VOL
FIELD CAPACITY	=	0.0450	VOL/VOL
WILTING POINT	=	0.0180	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1164	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999978000E-02	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 8 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 2.% AND A SLOPE LENGTH OF 210. FEET.

SCS RUNOFF CURVE NUMBER	=	72.90	
FRACTION OF AREA ALLOWING RUNOFF	=	90.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	28.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	4.695	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	11.952	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.092	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	32.094	INCHES
TOTAL INITIAL WATER	=	32.094	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
PORTLAND OREGON

STATION LATITUDE	=	45.53 DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50
START OF GROWING SEASON (JULIAN DATE)	=	117
END OF GROWING SEASON (JULIAN DATE)	=	293
EVAPORATIVE ZONE DEPTH	=	28.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	7.90 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	78.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	69.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	67.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	82.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR PORTLAND OREGON

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
6.16	3.93	3.61	2.31	2.08	1.47
0.46	1.13	1.61	3.05	5.17	6.41

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR PORTLAND OREGON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
38.90	43.20	45.90	50.40	56.70	62.50
67.70	67.30	62.70	54.30	45.50	40.90

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR PORTLAND OREGON
AND STATION LATITUDE = 45.53 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	5.05	2.82	1.81	2.03	3.75	0.41
	0.79	0.75	1.13	4.46	5.39	7.39
RUNOFF	0.004	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.009
EVAPOTRANSPIRATION	0.840	1.240	2.172	2.472	2.747	2.149
	0.755	0.714	0.974	1.496	0.920	0.671
PERCOLATION/LEAKAGE THROUGH	0.0505	3.0344	2.5410	1.8767	1.2937	0.8252
LAYER 3	0.8150	0.6873	0.5319	0.4580	0.2856	0.7336

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	35.78	129881.437	100.00
RUNOFF	0.013	46.636	0.04
EVAPOTRANSPIRATION	17.150	62253.820	47.93
PERC./LEAKAGE THROUGH LAYER 3	13.132841	47672.215	36.70
CHANGE IN WATER STORAGE	5.484	19908.697	15.33
SOIL WATER AT START OF YEAR	32.094	116502.086	
SOIL WATER AT END OF YEAR	37.579	136410.781	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.073	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 2

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	8.76	5.48	5.48	3.29	1.43	0.55
	0.08	2.72	1.18	1.96	6.46	7.56
RUNOFF	0.041	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.565	1.096	2.011	3.792	1.477	1.251
	0.080	2.581	1.094	1.051	0.746	0.492
PERCOLATION/LEAKAGE THROUGH	5.6180	6.0221	5.0786	3.5132	2.3225	1.6069
LAYER 3	1.2498	0.9296	0.6810	0.6020	0.4108	0.2540

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	44.95	163168.484	100.00
RUNOFF	0.041	150.266	0.09
EVAPOTRANSPIRATION	16.237	58940.988	36.12
PERC./LEAKAGE THROUGH LAYER 3	28.288450	102687.078	62.93
CHANGE IN WATER STORAGE	0.383	1390.177	0.85
SOIL WATER AT START OF YEAR	37.579	136410.781	
SOIL WATER AT END OF YEAR	37.962	137800.953	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.014	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 3

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	4.92	6.48	4.18	2.33	2.09	2.06
	0.39	1.06	1.48	3.65	7.37	10.26
RUNOFF	0.000	0.006	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.014	0.000
EVAPOTRANSPIRATION	0.889	1.199	1.935	2.677	2.711	2.565
	0.387	1.007	0.707	1.548	0.778	0.518
PERCOLATION/LEAKAGE THROUGH LAYER 3	3.9524	4.7202	4.7517	2.8155	2.4332	1.4327
	1.1626	0.9048	0.6840	0.5683	0.3577	2.1792

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	46.27	167960.109	100.00
RUNOFF	0.020	71.860	0.04
EVAPOTRANSPIRATION	16.921	61423.770	36.57
PERC./LEAKAGE THROUGH LAYER 3	25.962360	94243.367	56.11
CHANGE IN WATER STORAGE	3.367	12221.095	7.28
SOIL WATER AT START OF YEAR	37.962	137800.953	
SOIL WATER AT END OF YEAR	40.064	145431.234	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	1.265	4590.816	2.73
ANNUAL WATER BUDGET BALANCE	0.0000	0.021	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 4

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	6.81	3.49	3.28	2.65	1.57	0.65
	0.25	0.91	1.83	3.91	5.34	3.80
RUNOFF	0.001	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.661	1.199	1.971	2.973	2.373	0.783
	0.172	0.933	1.161	1.457	0.844	0.595
PERCOLATION/LEAKAGE THROUGH LAYER 3	6.7461	6.0251	3.7698	1.8030	2.2554	1.4413
	1.1639	0.8778	0.6663	0.5608	0.3236	0.4211

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.49	125198.703	100.00
RUNOFF	0.001	3.301	0.00
EVAPOTRANSPIRATION	15.123	54894.797	43.85
PERC./LEAKAGE THROUGH LAYER 3	26.053976	94575.930	75.54
CHANGE IN WATER STORAGE	-6.687	-24275.324	-19.39
SOIL WATER AT START OF YEAR	40.064	145431.234	
SOIL WATER AT END OF YEAR	34.641	125746.727	
SNOW WATER AT START OF YEAR	1.265	4590.816	3.67
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.000	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	3.80	5.91	3.99	1.37	2.44	1.30
	0.27	0.00	2.76	3.08	6.13	7.71
RUNOFF	0.000	0.097	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.765	1.152	2.109	2.206	2.513	1.715
	0.248	0.000	1.121	1.673	0.911	0.749
PERCOLATION/LEAKAGE THROUGH LAYER 3	2.4441	2.0365	4.2507	3.0474	2.1034	1.2214
	1.0699	0.8856	0.6875	0.5557	0.3583	1.9524

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	38.76	140698.781	100.00
RUNOFF	0.097	352.143	0.25
EVAPOTRANSPIRATION	15.162	55036.441	39.12
PERC./LEAKAGE THROUGH LAYER 3	20.612698	74824.094	53.18
CHANGE IN WATER STORAGE	2.889	10486.101	7.45
SOIL WATER AT START OF YEAR	34.641	125746.727	
SOIL WATER AT END OF YEAR	37.530	136232.828	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.000	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	5.87	4.84	3.75	2.33	2.26	0.99
	0.36	1.09	1.68	3.41	6.14	7.34
STD. DEVIATIONS	1.94	1.59	1.34	0.71	0.93	0.69
	0.27	1.00	0.67	0.95	0.84	2.30
RUNOFF						
TOTALS	0.009	0.021	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.003	0.002
STD. DEVIATIONS	0.018	0.043	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.006	0.004
EVAPOTRANSPIRATION						
TOTALS	0.744	1.177	2.040	2.824	2.364	1.693
	0.328	1.047	1.011	1.445	0.840	0.605
STD. DEVIATIONS	0.132	0.055	0.099	0.610	0.519	0.706
	0.264	0.945	0.184	0.235	0.077	0.107
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	3.7622	4.3677	4.0783	2.6111	2.0816	1.3055
	1.0923	0.8570	0.6501	0.5489	0.3472	1.1081
STD. DEVIATIONS	2.6409	1.7903	0.9928	0.7481	0.4564	0.3013
	0.1675	0.0969	0.0666	0.0540	0.0465	0.8947

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 5

	INCHES		CU. FEET	PERCENT
PRECIPITATION	40.05	(5.327)	145381.5	100.00
RUNOFF	0.034	(0.0380)	124.84	0.086
EVAPOTRANSPIRATION	16.118	(0.9526)	58509.97	40.246
PERCOLATION/LEAKAGE THROUGH LAYER 3	22.81006	(6.10225)	82800.531	56.95396
CHANGE IN WATER STORAGE	1.087	(4.7095)	3946.15	2.714

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	2.27	8240.100
RUNOFF	0.097	352.1429
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.421316	1529.37671
SNOW WATER	1.74	6306.4038

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2155
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0390

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	1.3798	0.2300
2	2.5826	0.1435
3	33.5673	0.1399
SNOW WATER	0.000	

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ATTACHMENT D6

MODEL OUTPUT FOR SCENARIO #5

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07   (1 NOVEMBER 1997)               **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:      C:\HELP3\M&B\WEATHER\VEG.D4
TEMPERATURE DATA FILE:        C:\HELP3\M&B\WEATHER\VEG.D7
SOLAR RADIATION DATA FILE:    C:\HELP3\M&B\WEATHER\VEG.D13
EVAPOTRANSPIRATION DATA:      C:\HELP3\M&B\WEATHER\VEG.D11
SOIL AND DESIGN DATA FILE:    C:\HELP3\M&B\DESIGN\S5.D10
OUTPUT DATA FILE:             C:\HELP3\M&B\OUTPUT\S5.OUT


TIME:  14: 3      DATE:   1/29/2004


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     TITLE:  McCormick & Baxter Upland Cap:  Scenario #5

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
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                      TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   8
          THICKNESS                  =        6.00    INCHES
          POROSITY                   =        0.4630 VOL/VOL
          FIELD CAPACITY             =        0.2320 VOL/VOL
          WILTING POINT              =        0.1160 VOL/VOL
          INITIAL SOIL WATER CONTENT =        0.2687 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.369999994000E-03 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
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LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1

THICKNESS	=	18.00 INCHES
POROSITY	=	0.4170 VOL/VOL
FIELD CAPACITY	=	0.0450 VOL/VOL
WILTING POINT	=	0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1337 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999978000E-02 CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.20 INCHES
POROSITY	=	0.8500 VOL/VOL
FIELD CAPACITY	=	0.0100 VOL/VOL
WILTING POINT	=	0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0970 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000 CM/SEC
SLOPE	=	2.00 PERCENT
DRAINAGE LENGTH	=	210.0 FEET

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.24 INCHES
POROSITY	=	0.7500 VOL/VOL
FIELD CAPACITY	=	0.7470 VOL/VOL
WILTING POINT	=	0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08 CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1

THICKNESS	=	240.00 INCHES

POROSITY	=	0.4170 VOL/VOL
FIELD CAPACITY	=	0.0450 VOL/VOL
WILTING POINT	=	0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0452 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999978000E-02 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 8 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 2.% AND A SLOPE LENGTH OF 210. FEET.

SCS RUNOFF CURVE NUMBER	=	72.90	
FRACTION OF AREA ALLOWING RUNOFF	=	90.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	24.2	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	4.038	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	10.451	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.021	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	15.067	INCHES
TOTAL INITIAL WATER	=	15.067	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
PORTLAND OREGON

STATION LATITUDE	=	45.53	DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50	
START OF GROWING SEASON (JULIAN DATE)	=	117	
END OF GROWING SEASON (JULIAN DATE)	=	293	
EVAPORATIVE ZONE DEPTH	=	24.2	INCHES
AVERAGE ANNUAL WIND SPEED	=	7.90	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	78.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	69.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	82.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR PORTLAND OREGON

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
6.16	3.93	3.61	2.31	2.08	1.47
0.46	1.13	1.61	3.05	5.17	6.41

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR PORTLAND OREGON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
38.90	43.20	45.90	50.40	56.70	62.50
67.70	67.30	62.70	54.30	45.50	40.90

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR PORTLAND OREGON
AND STATION LATITUDE = 45.53 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	5.05	2.82	1.81	2.03	3.75	0.41
	0.79	0.75	1.13	4.46	5.39	7.39
RUNOFF	0.005	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.009
EVAPOTRANSPIRATION	0.851	1.254	2.189	2.492	2.735	1.765
	0.788	0.752	1.126	1.508	0.927	0.677
LATERAL DRAINAGE COLLECTED FROM LAYER 3	4.9392	1.5922	0.6234	0.1403	0.1889	0.0838
	0.0000	0.0000	0.0039	1.1323	4.1055	5.8364
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.0111	0.0054	0.0042	0.0033	0.0033	0.0009
	0.0000	0.0000	0.0001	0.0046	0.0097	0.0126
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.0000	0.0000	0.0000	0.0001	0.0004	0.0004
	0.0005	0.0005	0.0004	0.0001	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 4	0.593	0.212	0.075	0.017	0.023	0.010
	0.000	0.000	0.000	0.136	0.509	0.700
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 4	0.491	0.154	0.081	0.015	0.018	0.021
	0.000	0.000	0.002	0.096	0.514	0.532

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	35.78	129881.437	100.00
RUNOFF	0.015	53.698	0.04
EVAPOTRANSPIRATION	17.064	61943.375	47.69
DRAINAGE COLLECTED FROM LAYER 3	18.6457	67683.883	52.11
PERC./LEAKAGE THROUGH LAYER 4	0.055118	200.077	0.15
AVG. HEAD ON TOP OF LAYER 4	0.1896		
PERC./LEAKAGE THROUGH LAYER 5	0.002472	8.972	0.01
CHANGE IN WATER STORAGE	0.053	191.519	0.15
SOIL WATER AT START OF YEAR	15.067	54691.496	
SOIL WATER AT END OF YEAR	15.119	54883.016	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.014	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 2

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	8.76	5.48	5.48	3.29	1.43	0.55
	0.08	2.72	1.18	1.96	6.46	7.56
RUNOFF	0.049	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.567	1.101	2.017	3.796	1.659	0.804
	0.080	2.709	1.157	1.036	0.762	0.500
LATERAL DRAINAGE COLLECTED FROM LAYER 3	7.8115	4.5342	3.8941	1.3278	0.3886	0.0132
	0.0000	0.0108	0.0000	0.1170	4.1380	5.6772
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.0157	0.0102	0.0094	0.0052	0.0034	0.0001
	0.0000	0.0002	0.0000	0.0018	0.0097	0.0123
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.0000	0.0000	0.0000	0.0001	0.0003	0.0005
	0.0005	0.0005	0.0005	0.0003	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 4	0.938	0.602	0.467	0.165	0.047	0.002
	0.000	0.001	0.000	0.014	0.513	0.681
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 4	0.744	0.459	0.304	0.167	0.039	0.008
	0.000	0.006	0.000	0.020	0.362	0.605

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	44.95	163168.484	100.00
RUNOFF	0.049	177.726	0.11
EVAPOTRANSPIRATION	16.189	58766.820	36.02
DRAINAGE COLLECTED FROM LAYER 3	27.9125	101322.234	62.10
PERC./LEAKAGE THROUGH LAYER 4	0.068095	247.184	0.15
AVG. HEAD ON TOP OF LAYER 4	0.2859		
PERC./LEAKAGE THROUGH LAYER 5	0.002631	9.549	0.01

CHANGE IN WATER STORAGE	0.797	2892.134	1.77
SOIL WATER AT START OF YEAR	15.119	54883.016	
SOIL WATER AT END OF YEAR	15.916	57775.152	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.020	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 3

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	4.92	6.48	4.18	2.33	2.09	2.06
	0.39	1.06	1.48	3.65	7.37	10.26
RUNOFF	0.000	0.009	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.015	0.000
EVAPOTRANSPIRATION	0.904	1.224	1.961	2.714	2.509	2.310
	0.390	1.038	0.778	1.532	0.803	0.521
LATERAL DRAINAGE COLLECTED FROM LAYER 3	4.5785	5.2025	2.5708	1.3937	0.3956	0.0000
	0.0000	0.0000	0.0000	0.4424	5.8391	9.2343
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.0105	0.0112	0.0073	0.0053	0.0026	0.0000
	0.0000	0.0000	0.0000	0.0029	0.0125	0.0180
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.0000	0.0001	0.0002	0.0004	0.0005	0.0005
	0.0005	0.0005	0.0005	0.0004	0.0001	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 4	0.550	0.691	0.309	0.173	0.048	0.000
	0.000	0.000	0.000	0.053	0.724	1.108
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 4	0.347	0.553	0.229	0.169	0.054	0.000
	0.000	0.000	0.000	0.064	0.830	0.735

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	46.27	167960.109	100.00
RUNOFF	0.024	86.165	0.05
EVAPOTRANSPIRATION	16.684	60562.797	36.06
DRAINAGE COLLECTED FROM LAYER 3	29.6570	107654.797	64.10
PERC./LEAKAGE THROUGH LAYER 4	0.070355	255.389	0.15
AVG. HEAD ON TOP OF LAYER 4	0.3046		
PERC./LEAKAGE THROUGH LAYER 5	0.003642	13.222	0.01
CHANGE IN WATER STORAGE	-0.098	-356.887	-0.21
SOIL WATER AT START OF YEAR	15.916	57775.152	
SOIL WATER AT END OF YEAR	14.553	52827.445	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	1.265	4590.816	2.73
ANNUAL WATER BUDGET BALANCE	0.0000	0.022	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 4

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	6.81	3.49	3.28	2.65	1.57	0.65
	0.25	0.91	1.83	3.91	5.34	3.80
RUNOFF	0.004	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

EVAPOTRANSPIRATION	0.666	1.214	1.989	3.099	1.963	0.828
	0.173	0.986	1.155	1.366	0.861	0.613
LATERAL DRAINAGE COLLECTED FROM LAYER 3	6.9893	2.4676	0.9865	1.6434	0.1500	0.0000
	0.0000	0.0000	0.1216	0.6856	4.5331	3.1897
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.0144	0.0069	0.0048	0.0057	0.0019	0.0000
	0.0000	0.0000	0.0006	0.0043	0.0104	0.0083
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.0001	0.0003	0.0005	0.0004	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0001	0.0003

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 4	0.839	0.317	0.118	0.204	0.018	0.000
	0.000	0.000	0.015	0.082	0.562	0.383
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 4	0.635	0.293	0.078	0.170	0.027	0.000
	0.000	0.000	0.040	0.064	0.512	0.354

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.49	125198.703	100.00
RUNOFF	0.004	14.949	0.01
EVAPOTRANSPIRATION	14.913	54132.492	43.24
DRAINAGE COLLECTED FROM LAYER 3	20.7668	75383.352	60.21
PERC./LEAKAGE THROUGH LAYER 4	0.057226	207.732	0.17
AVG. HEAD ON TOP OF LAYER 4	0.2115		
PERC./LEAKAGE THROUGH LAYER 5	0.001729	6.277	0.01
CHANGE IN WATER STORAGE	-1.195	-4338.379	-3.47
SOIL WATER AT START OF YEAR	14.553	52827.445	
SOIL WATER AT END OF YEAR	14.623	53079.883	
SNOW WATER AT START OF YEAR	1.265	4590.816	3.67
SNOW WATER AT END OF YEAR	0.000	0.000	0.00

ANNUAL WATER BUDGET BALANCE	0.0000	0.017	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	3.80 0.27	5.91 0.00	3.99 2.76	1.37 3.08	2.44 6.13	1.30 7.71
RUNOFF	0.000 0.000	0.123 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000
EVAPOTRANSPIRATION	0.779 0.270	1.165 0.000	2.128 1.084	2.215 1.690	2.564 0.927	1.442 0.760
LATERAL DRAINAGE COLLECTED FROM LAYER 3	2.9662 0.0000	4.6556 0.0000	2.3046 0.1606	0.5162 0.7695	0.2532 4.9423	0.0000 6.1983
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.0079 0.0000	0.0104 0.0000	0.0069 0.0007	0.0039 0.0044	0.0024 0.0110	0.0000 0.0131
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.0003 0.0000	0.0001 0.0000	0.0002 0.0000	0.0000 0.0000	0.0000 0.0001	0.0000 0.0002

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 4	0.356 0.000	0.619 0.000	0.277 0.020	0.064 0.092	0.030 0.613	0.000 0.744
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 4	0.307 0.000	0.755 0.000	0.179 0.050	0.056 0.092	0.037 0.416	0.000 0.535

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT

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PRECIPITATION	38.76	140698.781	100.00
RUNOFF	0.123	448.030	0.32
EVAPOTRANSPIRATION	15.023	54532.363	38.76
DRAINAGE COLLECTED FROM LAYER 3	22.7665	82642.242	58.74
PERC./LEAKAGE THROUGH LAYER 4	0.060740	220.486	0.16
AVG. HEAD ON TOP OF LAYER 4	0.2346		
PERC./LEAKAGE THROUGH LAYER 5	0.000960	3.483	0.00
CHANGE IN WATER STORAGE	0.846	3072.651	2.18
SOIL WATER AT START OF YEAR	14.623	53079.883	
SOIL WATER AT END OF YEAR	15.469	56152.535	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.007	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	5.87	4.84	3.75	2.33	2.26	0.99
	0.36	1.09	1.68	3.41	6.14	7.34
STD. DEVIATIONS	1.94	1.59	1.34	0.71	0.93	0.69
	0.27	1.00	0.67	0.95	0.84	2.30
RUNOFF						
TOTALS	0.012	0.026	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.003	0.002
STD. DEVIATIONS	0.021	0.054	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.007	0.004

EVAPOTRANSPIRATION

TOTALS	0.753	1.191	2.057	2.863	2.286	1.430
	0.340	1.097	1.060	1.426	0.856	0.614
STD. DEVIATIONS	0.137	0.060	0.097	0.614	0.454	0.641
	0.276	0.992	0.160	0.247	0.074	0.108

LATERAL DRAINAGE COLLECTED FROM LAYER 3

TOTALS	5.4569	3.6904	2.0759	1.0043	0.2753	0.0194
	0.0000	0.0022	0.0572	0.6294	4.7116	6.0272
STD. DEVIATIONS	1.9452	1.5675	1.3134	0.6422	0.1129	0.0365
	0.0000	0.0048	0.0778	0.3785	0.7164	2.1520

PERCOLATION/LEAKAGE THROUGH LAYER 4

TOTALS	0.0119	0.0088	0.0065	0.0047	0.0027	0.0002
	0.0000	0.0000	0.0003	0.0036	0.0106	0.0129
STD. DEVIATIONS	0.0031	0.0025	0.0021	0.0010	0.0006	0.0004
	0.0000	0.0001	0.0003	0.0012	0.0012	0.0035

PERCOLATION/LEAKAGE THROUGH LAYER 5

TOTALS	0.0001	0.0001	0.0002	0.0002	0.0002	0.0003
	0.0003	0.0003	0.0003	0.0002	0.0001	0.0001
STD. DEVIATIONS	0.0001	0.0001	0.0002	0.0002	0.0002	0.0003
	0.0003	0.0003	0.0002	0.0002	0.0001	0.0001

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.6549	0.4881	0.2491	0.1245	0.0330	0.0024
	0.0000	0.0003	0.0071	0.0755	0.5843	0.7234
STD. DEVIATIONS	0.2335	0.2105	0.1576	0.0796	0.0136	0.0045
	0.0000	0.0006	0.0096	0.0454	0.0888	0.2583

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	40.05 (5.327)	145381.5	100.00

RUNOFF	0.043	(0.0479)	156.11	0.107
EVAPOTRANSPIRATION	15.975	(0.9709)	57987.57	39.886
LATERAL DRAINAGE COLLECTED FROM LAYER 3	23.94967	(4.68882)	86937.297	59.79942
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.06231	(0.00667)	226.174	0.15557
AVERAGE HEAD ON TOP OF LAYER 4	0.245	(0.049)		
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00229	(0.00101)	8.301	0.00571
CHANGE IN WATER STORAGE	0.080	(0.8306)	292.21	0.201

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	2.27	8240.100
RUNOFF	0.123	448.0303
DRAINAGE COLLECTED FROM LAYER 3	0.89939	3264.78638
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.001550	5.62720
AVERAGE HEAD ON TOP OF LAYER 4	3.346	
MAXIMUM HEAD ON TOP OF LAYER 4	5.402	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	40.4 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000016	0.05828
SNOW WATER	1.74	6306.4038

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2428
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0422

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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